PRACTICAL PHYSICS VOLUME -II

Volume- II [B.Sc.-Semester –II,IV & VI]

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Preface

We feel highly pleased to present this book entitled "**Practical Physics**" written strictly to aquatint undergraduate student to Laboratory work. Since student need help to understand the experiment.

The writing contained herein are not based on my study of books but also on my personal experience in teaching. I have included various steps which is useful how to perform experiment in laboratory

The main purpose of this book is to give starting idea regarding experiment in subject Physics.

In 21st century research technology holds a lot of promise in terms of its potential, application and product. However, for authors of a book, it becomes difficult to present such a vast subject in few pages. We are confidence that, our presentation is unique and it will definitely in cultivate student interest in Laboratory work.

Any errors, omissions and suggestion for the improvement of this volume, brought to our notice, will be thankfully acknowledge and incorporated in next edition.

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Acknowledgement

I would like to thanks Dr. A. L. Kulat, Pricipal, Shri Shivaji Arts, Commerce and Science college, Akot for their moral support and constant inspiration while writing the books.

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I am also thankful to Author of reference books and online reference article based on the syllabus of SGB Amravati University, Amravati in subject Physics.

Lastly it is our great pleasure to acknowledge the publisher "____________________" for designing and lay outing of this book.

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Experiment No:-01

Inductor:- An inductor is a passive electronic component that storesenergy in the form of a magnetic field. In its simplest form, an inductor consistsof a wire loop or coil. The inductance is directly proportional to the number ofturns in the coil. Inductance also depends on the radius of the coil and on the type of material around which the coil is wound. The standard unit of inductance is the henry, abbreviatedH. This is a large unit. More common units are the microhenry, abbreviated μH (1 μH $=10^{-6}$H) and the millihenry, abbreviated mH (1 mH $=10^{-3}$ H). Occasionally, the nanohenry (nH) is used (1 nH = 10^{-9} H).

Inductance:- the property of an electric circuit by which a varying current in it produces a varying magnetic field that induces voltages in the same circuit or in a nearby circuit: it is measured in henrys: symbol, L

 the capacity of an electric circuit for producing a counter electromotive force when the current changes

Aim : To determine inductance (L) by three voltage method.

Objective :

1. Measurement of inductance by phasor diagram method.

Apparatus :Step down transformer, inductance coil, , resistance box, voltmeter , connecting wires etc.

Formulae :

$$L = \frac{V_L}{V_R}\frac{R}{2\pi f}$$

Where,

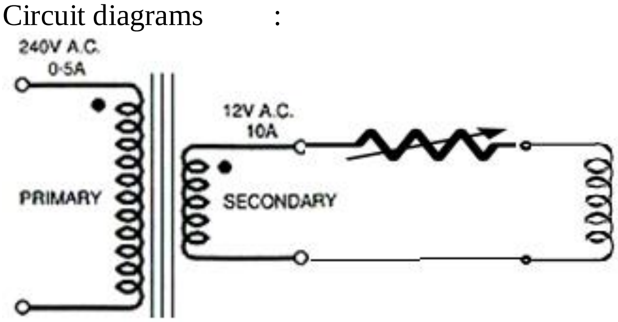
V_L = a.c. voltage across inductance (from phaser diagram).

V_R = a.c. voltage across resistance R.

f= frequency of a.c. mains (50Hz in india)

R= resistance from R.B.

Circuit diagrams :



Procedure :

Part – I for determining Inductance L.

1. Connect the various components as shown in fig 1. The step down transformer, of which output voltage should be around 6 to 9 volt ac at 500mA and R.B. is a resistance box, in which provision for resistance upto 100 ohm should be available. The inductance L is choke of few mH capable of withstanding about 500mA of current through it.
2. ‘Put on’ the ac source, take out suitable resistance say 500 ohm from the resistance box. Measure voltages V_L' , V_r and V_R as explained earlier, using a voltmeter with a very high input impedance. The value of R from the R.B. should be such that the magnitude of V_L' , V_r and V_R should be of the same order.
3. Change the resistance from the resistance box, and repeat the steps mentioned above, by taking at least six different values of R from the resistance box.
4. Repeat steps 1,2 and 3 for another inductor if possible.
5. Record your observation as shown in table 1.

Observation :

Table No. 1 – For L (here f = 50Hz in India)

S. R.	Resistance from R.B. R ohm	Voltage measured			From Phasor diagram V_L (Volt)	$L = \frac{V_L}{V_R}\frac{R}{2\pi f}$ (mH)	Mean L (mH)
		V_R	V'_L	V_T			
1							
2							
3							
4							
5							

Calculation:

For inductance L:

Draw a phasor diagram as shown in fig as explained earlier, for each set of observation reading. Determine the voltage V_L from the respective phasor diagram. Calculate L using the formula,

$$L = \frac{V_L}{V_R}\frac{R}{2\pi f}$$

=

=

=

Result :

1. The mean value of inductance (L) is found to be _______ mH.
2. The mean value of Capacitance (C) is found to be _______μF.

.

Source of error & Precaution:

1. While taking out various resistance from R.B. see that R is not too small. Even when you are not taking reading and if a.c. supply is ‘ON’ , some high resistance from R.B. must be taken out. Otherwise a large current may be drawn from the transformer does not get heated during the experiment.

2. The voltage measuring instrument must have high input impedance, to avoid loading effect, i.e. in order to get correct reading.

Student Activity:-

Find out the inductance of the wire of same length which wound on iron core and wood. Discuss the result in group.

Experiment No:-02

Capactior:- The capacitor is a component which has the ability or "capacity" to store energy in the form of an electrical charge producing a potential difference (*Static Voltage*) across its plates, much like a small rechargeable battery.

Capacitance:- Capacitance is defined as being that a capacitor has the capacitance of **One Farad** when a charge of **One Coulomb** is stored on the plates by a voltage of **One volt**. Note that capacitance, C is always positive in value and has no negative units. However, the Farad is a very large unit of measurement to use on its own so sub-multiples of the Farad are generally used such as micro-farads, nano-farads and pico-farads, for example.

Standard Units of Capacitance

- Microfarad (μF) 1μF = 1/1,000,000 = 0.000001 = 10^{-6} F
- Nanofarad (nF) 1nF = 1/1,000,000,000 = 0.000000001 = 10^{-9} F
- Picofarad (pF) 1pF = 1/1,000,000,000,000 = 0.000000000001 = 10^{-12} F

Aim : To determine capacitance (C) by three voltage method.

Objective :

1. Measurement of capacitance by phasor diagram method.

Apparatus :Step down transformer, condenser, resistance box, voltmeter , connecting wires etc.

Formulae :

$$C = \frac{V_R}{V_C}\frac{1}{2\pi fR}$$

Where,

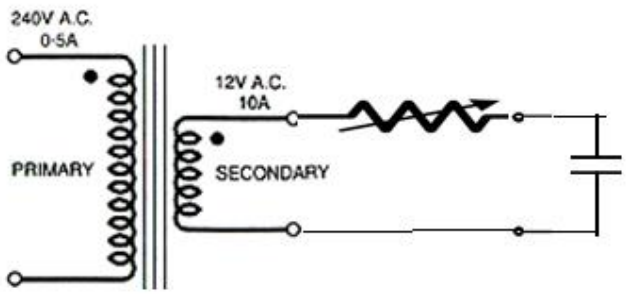
V_C =a.c. voltage across condenser (from phaser diagram)

V_R = a.c. voltage across resistance R.

f= frequency of a.c. mains (50Hz in india)

R= resistance from R.B.

Circuit diagrams :



Procedure :

Part – I for determining capacitance C.

1. Connect the various components as shown in fig.2 where the stepdown transformer used should have a current rating of about 500mA, and output voltage of say 6 to 9 V. Capacitor C is normally a combination of two 0.47 microfarad at 20 Volt. The resistance box used should also have provision for few kilo ohms.
2. Close the circuit and measure the three voltages V'_C, V_T and V_R across capacitance C, across R and C and across only R. The voltmeter used should have a very high input impedance.
3. To obtain various sets take three different values of resistances from the resistance box, and repeat the steps mentioned in 2 above.
4. Change the capacitance C and repeat the steps mentioned in 2 and 3 if possible.
5. Connect the two capacitance (i) in series and then (ii) in parallel and repeat the steps mentioned in 2 and 3 above.
6. Enter your observations as shown in table 2

Observation :

Table No. – For C (here f = 50Hz in india)

S. R.	Resistance from R.B. R ohm	Voltage measured			From Phasor diagram V_C (Volt)	$C = \frac{V_R}{V_C}\frac{1}{2\pi f R}$ (μF)	Mean C (μF)
		V_R	V'_C	V_T			
1							
2							
3							
4							
5							

Calculation:

For capacitance C:

Draw a phasor diagram as shown in fig as explained earlier. Determine the voltage V_C from the phasor diagram for each set and calculate C using formula

$$C = \frac{V_R}{V_C}\frac{1}{2\pi f R}$$

=

=

=

Result :

1. The mean value of Capacitance (C) is found to be _______μF.
2. From set 2 and 3 , the laws of capacitance in series and parallel are verified.

Source of error & Precaution:

1. While taking out various resistance from R.B. see that R is not too small. Even when you are not taking reading and if a.c. supply is 'ON' , some high resistance from R.B. must be taken out. Otherwise a large current may be drawn from the transformer does not get heated during the experiment.
2. The voltage measuring instrument must have high input impedance, to avoid loading effect, i.e. in order to get correct reading.

Student Activity:- Discuss the different types of capacitor and used different types of capacitor and find out capacitance by three voltage method.

Experiment No:-03

Law of capacitance:- *The equivalent capacitance of two capacitors connected in parallel is the sum of the individual capacitances.*

The reciprocal of the equivalent capacitance of two capacitors connected in series is the sum of the reciprocals of the individual capacitances.

Aim : To verify the law of capacitances.

Objective :

1. Measurement of capacitance by phasor diagram method.
2. Measurement of Series combination capacitance by phasor diagram method.
3. Measurement of Parallel Combination capacitance by phasor diagram method.

Apparatus :Step down transformer, condenser, resistance box, voltmeter , connecting wires etc.

Formulae :

$$C = \frac{V_R}{V_C}\frac{1}{2\pi f R}$$

$$\mathbf{1/C_s = 1/C_1 + 1/C_2}$$

$$\mathbf{C_p = C_1 + C_2}$$

Where,

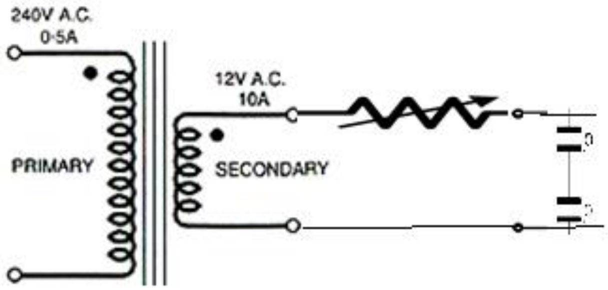
V_C =a.c. voltage across condenser (from phaser diagram)

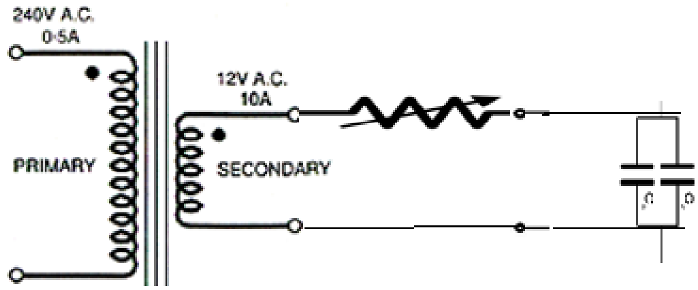
V_R = a.c. voltage across resistance R.

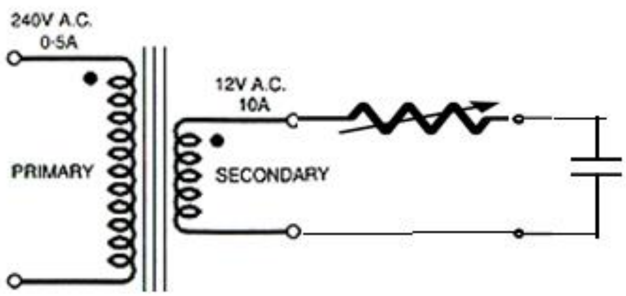
f= frequency of a.c. mains (50Hz in india)

R= resistance from R.B.

Circuit diagrams :







Procedure :

Part – I for determining capacitance C.

1. Connect the various components as shown in fig.2 where the stepdown transformer used should have a current rating of about 500mA, and output voltage of say 6 to 9 V. Capacitor C is normally a combination of two 0.47 microfarad at 20 Volt. The resistance box used should also have provision for few kilo ohms.
2. Close the circuit and measure the three voltages V'_C, V_T and V_R across capacitance C, across R and C and across only R. The voltmeter used should have a very high input impedance.
3. To obtain various sets take three different values of resistances from the resistance box, and repeat the steps mentioned in 2 above.
4. Change the capacitance C and repeat the steps mentioned in 2 and 3 if possible.
5. Connect the two capacitance (i) in series and then (ii) in parallel and repeat the steps mentioned in 2 and 3 above.
6. Enter your observations as shown in table 2

Observation :

Table No. – For C-1 (here f = 50Hz in india)

S.	Resistance from	Voltage measured	From	C	Mean	

R.	R.B. R ohm	V_R	V'_C	V_T	Phasor diagram V_C (Volt)	$= \frac{V_R}{V_C}\frac{1}{2\pi f R}$ (μF)	C (μF)	
For C-1 (here f = 50Hz in india)								
1								
2								
3								
For C-2 (here f = 50Hz in india)								
1								
2								
3								
For C-S (here f = 50Hz in india)								
1								
2								
3								
For C-P (here f = 50Hz in india)								
1								
2								
3								

Calculation:

For capacitance C:
Draw a phasor diagram as shown in fig as explained earlier. Determine the voltage V_C from the phasor diagram for each set and calculate C using formula

$$C = \frac{V_R}{V_C}\frac{1}{2\pi f R}$$

=

=

=

$1/C_s = 1/C_1 + 1/C_2$

$C_p = C_1 + C_2$

Result :

1. The mean value of Capacitance (C-1) is found to be ________μF.
2. The mean value of Capacitance (C-2) is found to be ________μF.
3. The mean value of Capacitance (C-S) is found to be ________μF.
4. The mean value of Capacitance (C-P) is found to be ________μF.

Conclusion:-

5. From set 2 and 3 , the laws of capacitance in series and parallel are verified.

Source of error & Precaution:

- While taking out various resistance from R.B. see that R is not too small. Even when you are not taking reading and if a.c. supply is ‘ON’ , some high resistance from R.B. must be taken out. Otherwise a large current may be drawn from the transformer does not get heated during the experiment.

- The voltage measuring instrument must have high input impedance, to avoid loading effect, i.e. in order to get correct reading.

Student Activity:-

Discuss the result in group. Campare the equivalent resistor in series and parallel combination.

Experiment No:04

Transformer:- A **transformer** is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. A varying current in one coil of the transformer produces a varying magnetic field, which in turn induces a varying electromotive force (emf) or "voltage" in a second coil. Power can be transferred between the two coils through the magnetic field, without a metallic connection between the two circuits.

A single-phase transformer can operate to either increase or decrease the voltage applied to the primary winding. When a transformer is used to "increase" the voltage on its secondary winding with respect to the primary, it is called a **Step-up transformer**. When it is used to "decrease" the voltage on the secondary winding with respect to the primary it is called a **Step-down transformer**.

turns ratio:- As the transformer is basically a linear device, a ratio now exists between the number of turns of the primary coil divided by the number of turns of the secondary coil. This ratio, called the ratio of transformation, more commonly known as a transformers "turns ratio",

Transformers Turns Ratio

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = n = \text{Turns Ratio}$$

Aim : Study of transformer.

Objective : to determine its various parameters L_P, L_S, n, K and M

Apparatus : Step down transformer, transformer under study, high resistance box, sensitive voltmeter with high input impedance, connecting wire etc.

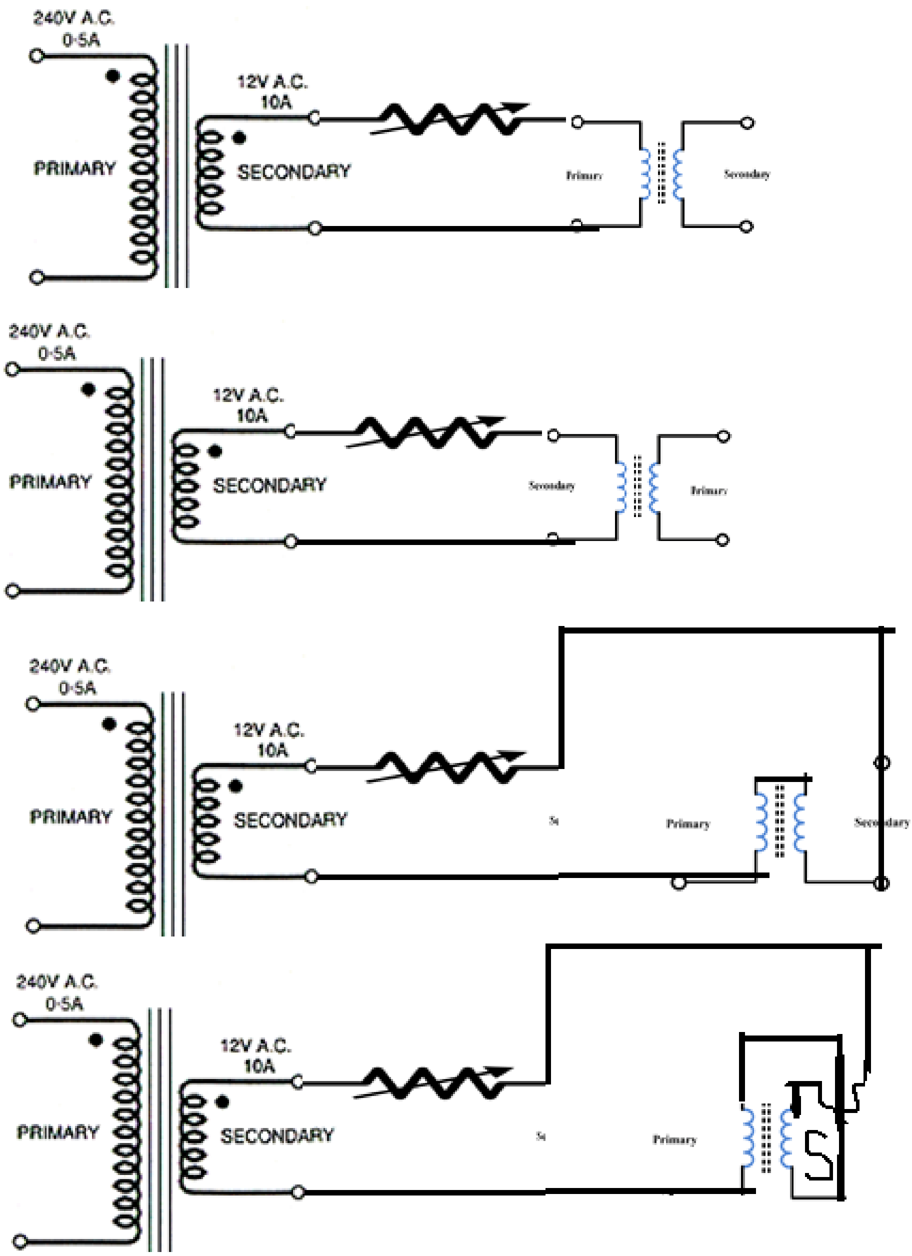
Formulae :

1. Inductance of primary,
$$L_p = \frac{V_{LP}}{V_R} \cdot \frac{R}{2\pi f}$$
2. Inductance of secondary,
$$L_S = \frac{V_{LS}}{V_R} \cdot \frac{R}{2\pi f}$$
3. Turn ratio
$$n = \frac{N_2}{N_1} = \sqrt{\frac{L_S}{L_p}}$$
4. Mutual Inductance
$$M = \frac{L_x - L_Y}{4}$$
5. Coupling constant,
$$K = \frac{M}{\sqrt{L_p L_S}}$$

Where ,V_{LP}- ac voltage across primary of the transformer, V_{LS}- ac voltage across secondary of the transformer,

R- Resistance from resistance box, N1- no. of turns of primary, N2- no. of turns of secondary, Lx- inductance of arrangement when Lp and Ls are in series., Ly- inductance of arrangement when Ls and Lp are in parallel., f- frequency of ac source. = 50Hz in India.

Circuit Diagram :



Procedure :

Part I- measurement of Lp of inductance of the primary.

1. The transformer on the left in figure shown in dotted box is the step down transformer, while the second transformer ,connected after the resistance box, is the experimental transformer.
2. One can immediately see that between point Aand C, we have the combination of L and R. Inductance of primary can be found out by three voltage method.
3. Take three different values of resistance from the high resistance box, and in each case measure the voltages V_R, V'_{LP}, and V_T across AB, BC and AC respectively. Draw phasor diagram in each case and find out voltage V_{LP} across the pure inductance.
4. Then determine the inductance L_P of primary by using formula of L_P.

5. Similarly process (1-4) is used for to determine L_s , L_x and L_Y.

Note : It should be noted that in a step down transformer, the resistance of primary is high (few ohm) as compared to that of secondary (few ohm, say 10 to 50 ohm). When primary of the transformer is connected (secondary open), take resisstace from resistance box of the order of kilo ohms, for determining Lp and when secondary is connected (Primary open),for determining Ls take risistance from resistance box of the order of few ohms only. While in determination of Lx and Ly value of R should be high. This is done taking in mind, that the voltage V_T Should get nearly equally divided across R and the Lp, Ls, Lx and Ly as per the case may be.

Observation :

Table No. 1- For Lp

S.R.	R (Ω)	V_T	V'_{LP}	V_R	From phasor diagram V_{LP}	$L_p = \frac{V_{LP}}{V_R} \cdot \frac{R}{2\pi f}$	Mean L_p in mH
1							
2							
3							
4							
5							

Table No. 2- For Ls

S.R.	R (Ω)	V_T	V'_{LS}	V_R	From phasor diagram V_{LS}	$L_S = \frac{V_{LS}}{V_R} \cdot \frac{R}{2\pi f}$	Mean L_S in mH
1							
2							
3							
4							
5							

Table No. 3 – For Lx

S.R.	R (Ω)	V_T	V'_X	V_R	From phasor diagram V_X	$L_x = \frac{V_X}{V_R} \cdot \frac{R}{2\pi f}$	Mean L_X in mH
1							
2							
3							
4							
5							

Table No. 4- For L_Y

S.R.	R (Ω)	V_T	V'_X	V_R	From phasor diagram V_X	$L_Y = \frac{V_Y}{V_R} \cdot \frac{R}{2\pi f}$	Mean L_Y in mH
1							
2							
3							
4							
5							

Calculation: Draw phasor diagrams for set of observations in Table 1, Table 2, Table3 & Table 4 and calculate the pure value of V_{LS} , V_{LP} , V_{Lx} and V_{Ly} . Substitute them in respective formulae and calculate Lp, Ls, Lx an Ly expressed in mH(milli hennery)

1. Turn ratio

$$n = \frac{N_2}{N_1} = \sqrt{\frac{L_S}{L_p}}$$

=

2. Mutual Inductance

$$M = \frac{L_x - L_Y}{4}$$

=

3. Coupling constant,

$$K = \frac{M}{\sqrt{L_p L_S}}$$

=

Result :

i. The inductance of primary colil Lp was found to be _____________mH.
ii. The inductance of primary colil Ls was found to be _____________mH.
iii. The mutual inductance of primary coil Lx was found to be _____________mH.
iv. The turn ratio of the given transformer was found to be ___________.
v. The coefficient of coupling constant of the given transformer was found to be___________.

Sources of Error & Precautions:

1. The resistance taken out through the resistance box should be large enough, so that the current through the transformer does not exceed its rated value.
2. The value of R from resistance box should be such that V_T nearly gets equally divided into two voltage across the components.
3. Input impedance of the a.c. voltmeter should be very high.

Student Activity:- Download the video on internet related to construction of transformer, Discuss the construction, working and result of above experiment in group.

Experiment No:-05

Maximum power transfer therorem: The maximum power transfer theorem states that in a linear , bilateral DC network , maximum power is delivered to the load when the load resistance is equal to the internal resistance of a source.

Load Resistance:- Load resistance is also a resistance, but it has a very specific meaning in the context of electric circuits; it is the resistance connected between the output stage of a circuit, and the ground.

This resistance draws in the power supplied from the circuit.

This resistance also signifies the resistance of the device or circuit that would be connected to the output stage. So our ceiling fans, tubelights, toasters, room heaters, etc are all considered as load resistance (more appropriately, load impedance) by the mains circuit.

A practical electrical power source which is a linear electric circuit may, according to Thévenin's theorem, be represented as an ideal voltage source in series with an impedance. This impedance is termed the **internal resistance** of the source. When the power source delivers current, the measured voltage output is lower than the no-load voltage; the difference is the voltage drop (the product of current and resistance) caused by the internal resistance. The concept of internal resistance applies to all kinds of electrical sources and is useful for analyzing many types of electrical circuits.

Aim : To study the power delivered by a source at different loads (Verification of Maximum power transfer theorem).

Apparatus : Regulated power supply , two resistance boxes, a d.c. voltmeter, connecting wires etc

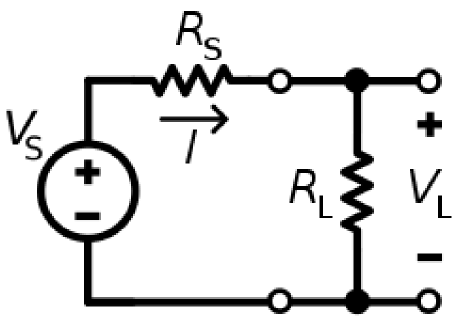
Formulae :

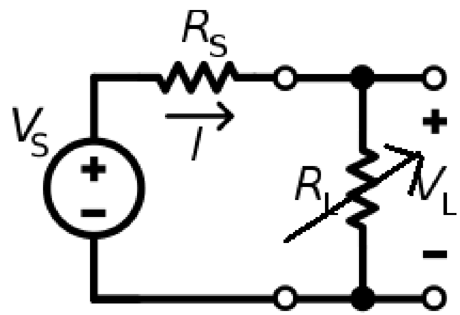
The power in the load is

$P = i^2 / R_L = V^2_L / R_L$

Maximum power transfer when $R_s = R_L$

Circuit diagrams :





Procedure :

1. Make the connection as shown in figure.
2. Take R_s = 500 ohm.
3. Switch 'ON' the power supply. Keep its inputs voltage V_s fix at say 5V.
4. Take R_L = 100 ohm, measure the voltage V_L across it by voltmeter .
5. Repeat the step (4) for various values of R_L ,such that 4-5 below of R_L and 4-5 reading beyond RL and every record VL.

Observation : Inputs voltage, Vs = _____ Volt

S.R.		R_s = ______ ohm			R_s = ______ ohm			R_s = ______ ohm			R_s = ______ ohm		
	R_L	V_L	$(V_L)^2$	$P = (V_L)^2/R_L$	V_L	$(V_L)^2$	$P = (V_L)^2/R_L$	V_L	$(V_L)^2$	$P = (V_L)^2/R_L$	V_L	$(V_L)^2$	$P = (V_L)^2/R_L$
1													
2													
3													
4													
5													
6													
7													
8													
9													

Calculation :

Using the relation

$P = V^2_L / R_L$ = ______Watt

Find P for various values of VL for corresponding values of RL.

Graph :Draw a graph taking power P along Y axis and load RL along Y axis.

Result : From graphs, we conclude that the maximum power is delivered from source to the load when $R_L = R_s$. This is known as impedance matching.

Sources of error and precautions :

1. Input voltage V_s should be kept fixed.
2. Resistances used for the load should have proper voltage.
3. Nearly 4-5 reading of R_L should be taken below and above that of R_s.

Student Activity:- Replace different types of battery and verify the Maximum power transfer therorem.

Experiment No:- 06

Thevenin's theorem states that any linear, two-terminal portion of a network can be replaced by a Thevenin equivalent circuit. A Thevenin equivalent circuit consists of a voltage source (V_{Th}) in series with a resistor (R_{Th}) where V_{Th} is the open-circuit voltage at terminals A-B and R_{Th} is the equivalent resistance at terminals A-B

.

Aim : To verify the Thevenin's theorem.

Apparatus : Power supplies, carbon resistances (or resistance box) and bread board, Voltmeter, connecting wires etc.

Formulae :

Current through R_L

$I = V_{oc} / (R_{eq} + R_L)$

V_{OC} open circuit voltage (with R_L disconnect)

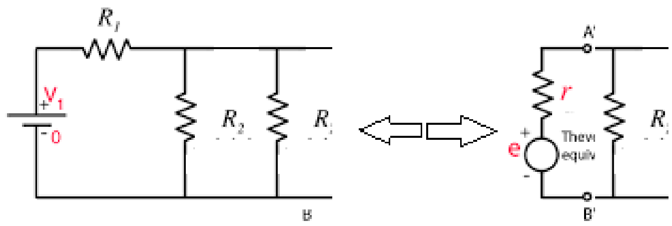
$V_{OC} = V_1R_2/ (R_1+R_2) = V_{TH}$

Equivalent resistance of the circuit is obtained by replacing the voltage source V by its internal resistance. The circuit is then shown in whine between points a and b , R_1 and R_2 appear to be parallel to each other. Hence the equivalent resistance is

$R_{eq} = (R_1R_2)/ (R_1 + R_2) = R_{TH}$

Statement : The Thevenin theorem states that 'any two terminal linear networks containing linear impedances and generators can be replaced by an equivalent circuit consisting of a voltage source V_{oc} in series with a resistance R_{eq}.'

Circuit diagrams :



Procedure :

1. For simplicity, we have taken the same circuit diagram as shown in figure with same voltage source as used in Thevinins theorem. Connect an ammeter and the short circuit current I_{SC}.
2. This value of I_{SC} measured should almost equal to its theoretical value V_{OC}/ R_{eq}. The value of R_{eq} is calculate
   Req = (R1.R2) / (R1+ R2)
3. Circuit is drawn as shown in figure. Here we have shown an equivalent current source circuit.

Observation :

S. R.	Battery Voltage V_i or V_B	R1	R2	RL	Calculated R_{TH}	V_O (Observed)	V_O (Calculated)
1							
2							
3							
4							
5							
6							
7							

Calculation:

Result : The voltage calculated from the circuit design and actually measured for a.c. / d.c. source agree with each other. Hence Thevenins theorem verified.

Student Activity:- Find out the result for above circuit, Also build up the circuit contain two or more source of emf and atleast five resistance find out the V_{TH} and R_{TH} for circuit and discuss this result in group and clarify the concept.

Experiment No:07

Norton theorem:-

Any Linear Electric Network or complex circuit with Current and Voltage sources can be replaced by an equivalent circuit containing of a single independent Current Source I_N and a Parallel Resistance R_N.

Simple Steps to Analyze Electric Circuit through Norton's Theorem

1. Short the load resistor
2. Calculate / measure the Short Circuit Current. This is the Norton Current (I_N)
3. Open Current Sources, Short Voltage Sources and Open Load Resistor.
4. Calculate /measure the Open Circuit Resistance. This is the Norton Resistance (R_N)
5. Now, Redraw the circuit with measured short circuit Current (I_N) in Step (2) as current Source and measured open circuit resistance (R_N) in step (4) as a parallel resistance and connect the load resistor which we had removed in Step (3). This is the Equivalent Norton Circuit of that Linear Electric Network or Complex circuit which had to be simplified and analyzed. You have done.
6. Now find the Load current flowing through and Load Voltage across Load Resistor by using the Current divider rule. $I_L = I_N / (R_N / (R_N + R_L))$

Difference between Current & Voltage Source

A **voltage source** is a two terminal device which can maintain a fixed voltage.[1] An ideal voltage source can maintain the fixed voltage independent of the load resistance or the output current.

A **current source** is an electronic circuit that delivers or absorbs an electric current which is independent of the voltage across it.

Aim : To verify Norton theorem.

Apparatus : Power supplies, carbon resistances and bread board (or resistance box), a current measuring instrument (milliammeter), connecting wires

Formulae :

$G_{eq} = 1/ R_{eq}$

Where G_{eq} = equivalent conductance.

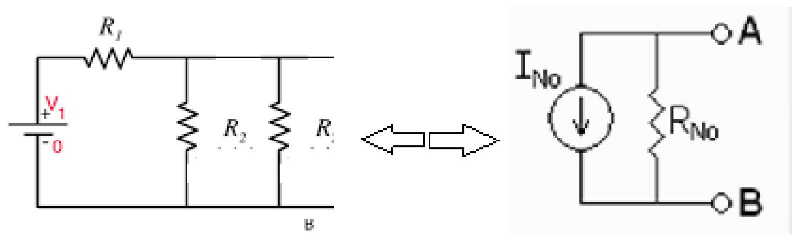
R_{eq} = equivalent resistance.

$I = V_{oc} / R_{eq}$

Where, V_{oc} = open circuit voltage.

Statement : Norton's Theorem. Any collection of batteries and resistances with two terminals is electrically equivalent to an ideal current source i in parallel with a single resistor r. The value of r is the same as that in the Thevenin equivalent and the current i can be found by dividing the open circuit voltage by r.

Circuit diagrams :



Procedure :

1. For simplicity, we have taken the same circuit diagram as shown in figure with same voltage source as used in Thevinins theorem. Connect an ammeter and the short circuit current I_{SC}.
2. This value of I_{SC} measured should almost equal to its theoretical value V_{OC}/ R_{eq}. The value of R_{eq} is calculate
   Req = (R1.R2) / (R1+ R2)
3. Circuit is drawn as shown in figure. Here we have shown an equivalent current source circuit.

Observation :

S. R.	Battery voltage Vi	R1	R2	RL	R_{eq} or R_{TH}	I_{SC} (observed)	I_{SC} (Theoretically)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Calculation:

Result : The value of current measured I_{SC} is almost equal to the theoretical value calculated. This verifies the Norton's theorem.

Student Activity:- Find out the result for above circuit, Also build up the circuit contain two or more source of emf and atleast five resistance find out the I_{SC} for circuit and discuss this result in group and clarify the concept.

Experiment No:-08

Kirchoff's Law:-

Kirchoff's Current Law:- KCL

At any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node or equivalently **The algebraic sum of currents in a network of conductors meeting at a point is zero**.

Kirchoff's Voltage Law:- KVL

The directed sum of the electrical potential differences (voltage) around any closed network is zero, or

More simply, the sum of the emfs in any closed loop is equivalent to the sum of the potential drops in that loop, or **The algebraic sum of the products of the resistances of the conductors and the currents in them in a closed loop is equal to the total emf available in that loop**.

Aim : To verify the Kirchoff's Law.

Objective : 1. To verify the Kirchoff's current law.
2. To verify the Kirchoff's Voltage law.

Apparatus : Power supplies, carbon resistances (or resistance box) and bread board, Voltmeter, milli- ammeter, connecting wires etc.

Formulae : $\Sigma I = 0$ i.e. $I_1 = I_2 + I_3$
$\Sigma emf = \Sigma IR$ i.e. $V = I_1R_1 + I_2R_2 + I_3R_3 = V_1 + V_2 + V_3$

Statement :

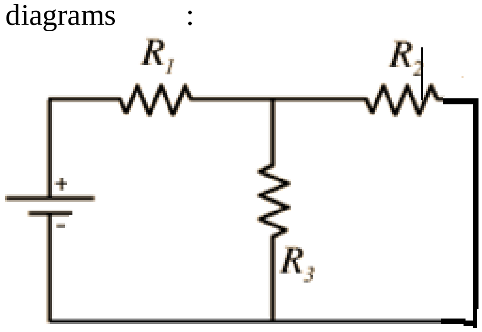
Kirchoff's Current Law: In any network, the algebraic sum of currents meeting at any node or junction in a circuit is Zero.

$$\Sigma I = 0 \text{ i.e. } I_1 = I_2 + I_3$$

Kirchoff's Voltage Law: In any "closed " mesh of a circuit, the algebraic sum of the potential difference i.e. product of current I and resistance R in each part of the mesh is equal to the algebraic sum of emf in that mesh.

$$\Sigma\, emf = \Sigma IR \text{ i.e. } V = I_1R_1 + I_2R_2 + I_3R_3 = V_1 + V_2 + V_3$$

Circuit diagrams :



Procedure :

1. Make the connection as shown in figure for KCL an KVL.
2. Take out suitable resistor from resistance boxes .Note down in observation table.
3. Note down the current flowing in each branch of the network.
4. Compared with Caculated and observer value of Current & Voltage by applying the KCL and KVL to the network.

Calculation:

Table No. 1For KCL:

S.N.	Battery	R_1	V_1	I_1	R_2	V_2	I_2	R_3	V_3	I_3	$I_1 = I_2$	$V_B=V_1+V_2$	KCL &

	Voltage V_B											or $V_B=V_1+V_3$	KVL Verifies
1													
2													
3													
4													
5													

Calculation :

Result : From Observation and calculation was found that,

1. Kirchoff's Current Law: In any network, the algebraic sum of currents meeting at any node or junction in a circuit is Zero.

$$\Sigma I = 0 \text{ i.e. } I_1 = I_2 + I_3$$

2. Kirchoff's Voltage Law: In any "closed " mesh of a circuit, the algebraic sum of the potential difference i.e. product of current I and resistance R in each part of the mesh is equal to the algebraic sum of emf in that mesh.

$$\Sigma \text{ emf} = \Sigma \text{ IR i.e. } V= I_1R_1+ I_2R_2+I_3R_3 = V_1 + V_2 + V_3$$

Hence, Kirchoff's law is verified.

Student Activity:-

Verify the result in Different two port electrical network and apply KCL and KVL to it and discuss the result in group.

Experiment No:-09

In electronics, the **Carey Foster bridge** is a bridge circuit used to measure medium resistances, or to measure small differences between two large resistances. It was invented by Carey Foster as a variant on the Wheatstone bridge. He first described it in his 1872 paper "On a Modified Form of Wheatstone's Bridge, and Methods of Measuring Small Resistances"

Aim : To determine the specific resistance of the material of given wire by Carey- Foster Bridge.

Apparatus : Carey –Foster's bridge, fractional resistance box, two equal resistance boxes, galvanometer, thick copper strip, Leclanche cell, plug key,jockey, experimental wire and connecting wires etc.

Formulae :Resistance per unit length Carey- Foster's Bridge wire

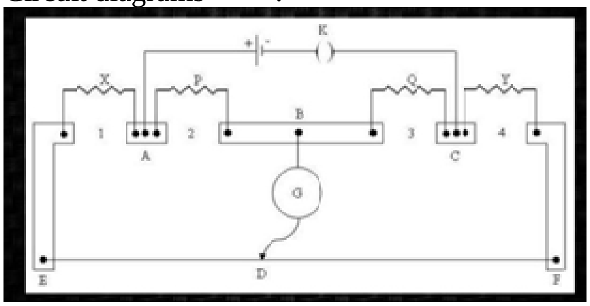
$K=\frac{X}{l_2 - l_1}$ ohm/cm

$$\rho = \frac{R\pi r^2}{L}$$

Where, ρ=is specific resistance of the material of the given wire. R= is resistance of the given wire

r is radius of the given wire, L is length of the given wire

Circuit diagrams :



Procedure : Part- I <u>To determine k</u>

1. Connect the circuit as shown in figure. With copper strip in the right gap and resistance box in left gap select P and Q to be nearly, say 500 ohm each.
2. Introduce some resistance X in the fractional resistance box and obtain the null point by tapping the jockey along the bridge wire. Note down the distance of the null point l_1 from the left end.
3. Now interchange the position of the resistance box and the copper strip. Again obtain the balance point keeping the same resistance in the resistance box. Note the position of the null points l_2 from left end.
4. Takes different sets of observations by changing the value of X by fractions of an ohm and repeating the steps 2 and 3. Record your observation as shown in fig.

Part II – Unknown resistance

1. Now connect the fractional resistance box in left gap and the experimental wire in the right gap. Obtain the balance point by introducing a suitable resistance in the resistance box. Note down the distance of the balance point l_1 from the left end. Interchange the positions of the resistance box and the wire and again obtain the null point l_2.
2. Take different sets by changing the value of the resistance from the resistance box. Note down the observation in table 2.
3. Measure the length L of the given wire.
4. Determine the radius of given wire by screw gauge at various points along and perpendicular to its length.

Observation : Room temperature = ______ ^{0}C

Table 1 for the determination of k

S. R.	Resistance from R.B.	Position of the null point with resistance box in	$l_1 - l_2$	$K=\frac{X}{l_2 - l_1}$	Mean k

	X ohm	Left gap l_1 cm	Left gap l_2 cm		ohm/cm	
1						
2						
3						
4						
5						

Table 2 - for the determination of resistance of wire.

S. R.	Resistance from R.B. X ohm	Position of the null point with resistance box in		l_1- l_2	K=$\frac{X}{l_2 - l_1}$ ohm/cm	Mean k
		Left gap l_1 cm	Left gap l_2 cm			
1						
2						
3						
4						
5						

Calculation:

a. Calculate the resistance per unit length per unit length of the bridge wire using the formula. K=$\frac{X}{l_2 - l_1}$ = ________ ohm/cm

b. Calculate the resistance of the wire by using the relation

R= X – k (l_2 – l_1) = _________ ohm

c. Calculate the specific resistance of the wire by using the formula

$$\rho = \frac{R\pi r^2}{L}$$

Result : The specific resistance of the material of given wire is ___ohm cm

Source of error & Precaution:

1. The resistance of the four arms should be of the same order, to ensure the maximum sensitivity of the bridge.
2. The jockey should be pressed gently and momentarily, otherwise it will spoil the uniformity of the bridge wire.
3. The cell circuit should be closed only when readings are being taken.
4. While determining the value of k the value of R should be comparable with resistance of the bridge wire.
5. Use thick copper strip so as to ensure r = 0

Student Activity:- Find out the information about different types of bridge to measure the resisatnce and discuss the similarity and difference of bridge in a group.

Experiment No:10

A potentiometer is an instrument used to measure an unknown e.m.f. which is compared with known e.m.f. thus it is a device used for measurement of unknown e.m.f. is compared with a known e.m.f. The known voltage may be supplied by a standard cell or any other known voltage. Measurements using comparison methods are capable of a high degree of accuracy because the result obtained does not depend on the actual deflection of a pointer, as is the case in deflection methods, but only upon the accuracy with which the voltage of the reference source is known.

Another advantage of the potentiometer is that since potentiometer makes use of balance or null condition, no current is flow and no power is consumed in the circuit containing the unknown e.m.f. when the instrument is balanced. Thus the determination of voltage by potentiometer is quite independent of the source resistance.

Aim : To determine low resistance by potentiometer.

Apparatus : Potentiometer, secondary cells or stabalised power supplies, rheostats, galvanometer, plug keys, milliammeter, two way key, resistance box, low resistance wire, connecting wires etc .

Formulae :

$$r = \left(\frac{l_2}{l_1} - 1\right) R$$

Where, r=Unknown low resistance, R= known fairly large resistance, l_1= balancing length of the potentiometer wire when p.d. across R alone is balanced, l_2= balancing length when p.d. across (R+r) is balanced.

Circuit diagrams :

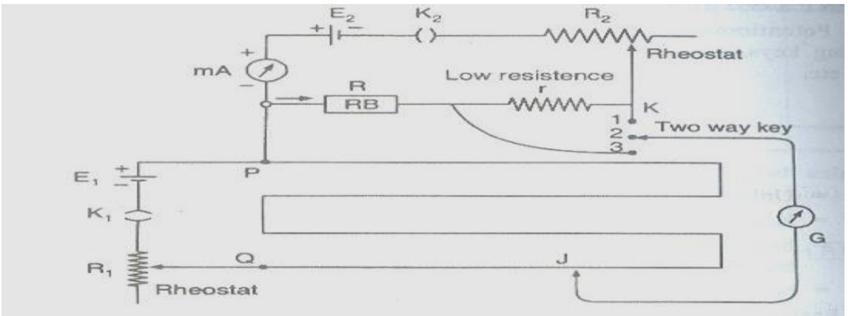


Fig. 24.14.

Procedure :

1. Connect various components as shown in figure.
   - i. In actual experiment, R is a resistance box, E_1 and E_2 are the two sources of emf which should be able supply about 500mA at 3V or 6V.
   - ii. The current in potentiometer wire should be adjusted such that the potential drop across the wire PQ is slightly more than potential drop across (R+r).
   - iii. In has been mentioned in theory earlier that current I flowing through (R+r) need not be known, but it must remain same for a set of observations. To ensure this, the milliammeter has been purposely included in the circuit, through the value of current I flowing through it does not appear in calculation.
2. Take a 2 ohm resistance from the resistance box R. Adjust the current in the milliammeter, to say 300mA.
3. Close the gap 1-2 of the two way key K and keep the other gap 2-3 open.Check the direction of deflection in the galvanometer, when the jockey J is near the negative end Q of the potentiometer wire.
4. Close the plug key K_1, and observe the deflection in the galvanometer when the jockey J is near point Q (viz. at say 999 cm in case of a 10 wire potentiometer). Adjust the rheostat R_1 to get a deflection slightly on the opposite direction.

5. Adjust the position of the jockey J to get the null point. Note the length of the wire (as measured from P) and let it be l_2.
6. Without changing the current in the milliammeter circuit, close the gap 2-3 of key K and keep gap 1-2 open. Adjust the position of jockey to get a null point. Let this length of the wire be l_1 (Note that l_1 is less than l_2).
7. Check the null point as obtained in 5 above by closing gap 1-2 (but 2-3 open) of key K. If it is slightly changed, then take the mean of two observations of l_2.
8. Repeat the procedure indicated in steps 5 to 7 above for different values of R (and hence I).

   Note :

   i. Adjust I in every case for almost same value of IR. Thus it will be easier to get null point near the easier position.
   ii. In the observation table the value of current as well as resistance R to be used for various sets have therefore to be so selected that the IR drop is almost same.
   iii. The milliammeter in the circuit, therefore, not only helps us to maintain a constant current, but it also enables us, to change the potential drop so as to get null point always on the last wire without much effort.

Observation :

S.R.	Resistance R ohm	Current in milliammeter (mA)	Length of potentiometer wire corresponding to		$r = \left(\frac{l_2}{l_1} - 1\right) R$ ohm
			Potential drop across (R+r) (l_2 cm)	Potential drop across R only (l_1 cm)	
1					
2					
3					
4					
5					

Calculation:

Calcualte the value of the unknown resistance r in each case by using the formula

$$r = \left(\frac{l_2}{l_1} - 1\right) R$$

=_____________ohm

And record it in the last column of the observation table. Find mean r.

Result: The mean value of the low resistance = ________ ohm

Standard value of the low resistance = ________ ohm

Percentage error = _________ %

Source of error & Precaution :

1. Weak currents should be used in both the circuit to prevent the heating of the resistances and of the potentiometer wire.
2. Short and thick connecting wires (of copper) should be used and all contacts must be clean and tight.
2. The jockey must have a sharp edge.

Student Activity:-

Replace Low resistance with High resistance and try to repeat experiment . Share your result and view in group.

Experiment No:-11

Walking on bathroom tile in winter is annoying since it feels so much colder than the carpet. This is interesting, since the carpet and tile are usually both at the same temperature (i.e. the temperature of the interior of the house). The different sensations we feel is explained by the fact that different materials transfer heat at different rates. Tile and stone conduct heat more rapidly than carpet and fabrics, so tile and stone feel colder in winter since they transfer heat out of your foot faster than the carpet does.

In general, good conductors of electricity (metals like copper, aluminum, gold, and silver) are also good heat conductors, whereas insulators of electricity (wood, plastic, and rubber) are poor heat conductors.

thermal conductivity

A measure of the ability of a material to transfer heat. Given two surfaceson either side of the materi al with a temperature difference betweenthem, the thermal conductivity is the heat energy transferred per unittime and per unit surface area, divided by the temperature difference. It is measured in watts per degree Kelvin.

Aim : To determine the thermal conductivity of a bad conductor by Lee's Disc method.

Apparatus : Lee and Charlton apparatus, bad conductor in the form of a disc, physical balance stop watch,vernier calipers, screw guage, steam generatior and balance.

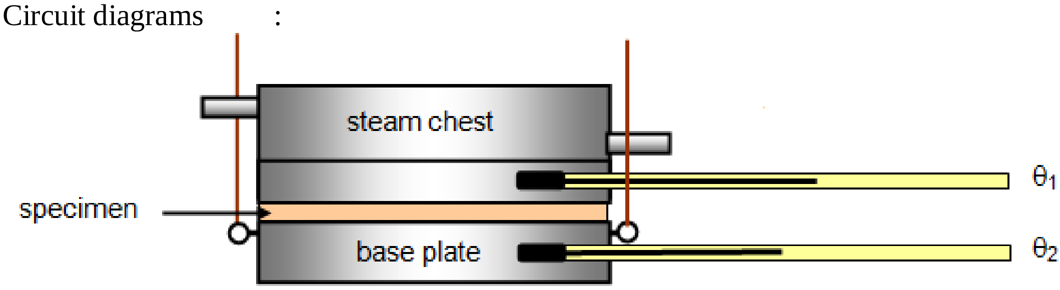
Formulae :

$$K = \frac{msd}{\pi \ r^2 (\theta_1 - \theta_2 \ )} (\frac{d\theta}{dt}) \frac{(r+2h)}{(2r+2h)}$$

Where,m= mass of cylinder D,s= specific heat of material of D, d= thickness of experimental disc S., r= radius of cylinder D.

h= height of cylinder D., θ_1 =temperature of cylinder D recorded by thermometer T1, θ_2 = temperature of steam recorded by thermo meter T1.

Circuit diagrams :



Procedure:

1. Suspend the disc D horizontally by means of threads from a stand after its weight has been taken. Cut a piece of cardboard of equal diameter. Determine its thickness carefully with a screw guage at a number of points. Determine the diameter of the disc D with a calipers in two mutually perpendicular directions. Rest the carboard on the disc and place the vessel C on it. The vessel and disc should be nickel plated on the outside to obtain good and uniform emissivity. Apply glycerine on the faces in contact, to provide good themal contacts.
2. Inset thermometers into holes provided in C and D for the purpose, such that they close to the cardboard S, one on either side. Connect C to steam generator.
3. The upper thermometer will at once show the temperature of steam θ_1. As heat flows across S, the lower thermometer will indicate a higher and higher temperature till the stationary state is reached and it indicates a constant θ_2. After this temperature has remainded constant for 4 to 5 minutes , note the temperature θ_1 & θ_2 carefully.
4. All heat passing across S is lost from the lower face and from the curved surface of D by radiation. The loss from the curved surface of S may be ignored as S is very thin and therefore , the area of its curved surface is negligible. The heat lost from its surface per second is $Q = \frac{KA(\theta_1 - \theta_2)}{d}$ calories, where A= πr^2 , is the face area of S and d is its thickness.
5. Remove C and S from the top of D. Heat D by means of a Bunsen flame, by passing the flame under its surface, till it indicates a temperature of about $(\theta_2 + 10)^0$.
6. Remove the flame and determine the temperature of D, every 30 seconds till its temperature falls to about $(\theta_2 - 10)^0$.
7. Draw a cooling curve as shown in figure between time and temperature and draw carefully a tangent to the curve at temperature θ_2 and determine the slope of the tangent at temperature θ_2 i.e.$(\frac{d\theta}{dt})$

Observation :

1. Mass of the disc D = _______ g
2. Diameter of disc D = _______cm
3. Radius of Disc D= ________ cm
4. Observations for θ_1 & θ_2
   Temperature θ_1 = ________
   Temperature θ_2 = _________
5. Observation for the cooling curve.

S.R.	Time	Temp of D

Calculation:

$$K = \frac{msd}{\pi\ r^2(\theta_1 - \theta_2)}\left(\frac{d\theta}{dt}\right)\frac{(r+2h)}{(2r+2h)}$$

Result : The thermal conductivity of cardboard

= ______________ cal.cm^{-1}sec^{-1} degree C^{-1}

Source of error & Precaution :

1. The thermometer, being a little away from the faces of S, may not indicate the correct temperatures of its faces.
2. Newton's law of cooling is not strictly applicable to the cooling body.
3. Thermometer should be placed close to the faces of S, one on either side.

Student Activity:

Replace the given insulator materials with different two or three insulator materials and find out thermal conductivity of the material and compare it's. Discuss the result.

Experiment No:12

Series Resonance:- In a series RLC circuit there becomes a frequency point were the inductive reactance of the inductor becomes equal in value to the capacitive reactance of the capacitor. In other words, $X_L = X_C$. The point at which this occurs is called the **Resonant Frequency** point, (f_r) of the circuit, and as we are analysing a series RLC circuit this resonance frequency produces a **Series Resonance**.

Quality factor:- The sharpness of the peak is measured quantitatively and is called the **Quality factor, Q** of the circuit. The quality factor relates the maximum or peak energy stored in the circuit (the reactance) to the energy dissipated (the resistance) during each cycle of oscillation meaning that it is a ratio of resonant frequency to bandwidth and the higher the circuit Q, the smaller the bandwidth, $Q = f_r$ /BW.

Aim:- To study a series resonant LCR circuit, its resonate frequency and quality factor.

Apparatus:- Inductance and capacitance of known values, resistance box preferably a decade resistance box , an AF oscillator, a step down transformer, CRO etc.

Formula:-

Resonant frequency,

$$Resonant\ frequency\ :- \qquad f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$Band\ width(B.W.):- \qquad \Delta f \ = f_2 - f_1 = \frac{f_r}{Q}$$

$$Quality\ factor\ \ Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{f_r}{B.W} = \frac{\omega_r L}{R} = \frac{1}{\omega_r CR}$$

Where, f1 and f2 are lower and upper half power point frequencies.

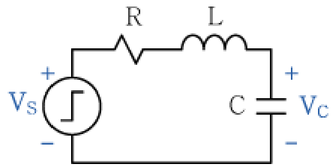
$\omega_r = 2\pi f_r$ where f_r is resonant frequency.

L- inductance connected.

C- capacitance connected.

R – resistance from decade R.B.

Circuit Diagram:-



Transfer function: $\dfrac{V_C(s)}{V_S(s)} = \dfrac{1}{LCs^2 + RCs + 1}$

$f_r = \dfrac{1}{2\pi\sqrt{LC}}$ $Q_f = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

Procedure:-

1. Connect the various components as shown in figure. Where R is the resistance box, L the given inductor and C the capacitor.
2. Adjust the output of audio/ oscillator for an appropriate value and keep it constant throughout the experiment.
3. Change frequency of the audio oscillator from lower limit say 100 Hz to the highest frequency upto 1,00,000 Hz in suitable steps. For every frequency of the audio oscillator note the output voltage across the capacitance C.
4. You may repeat the experiment for different combination of L,C & R.

Observation:-

For L=_______________ mH, C=________________ microfarade and R= ______________ ohm

Observation Table:-

S.N.	Frequency in Hz	Input Voltage V_i	Output voltage V_o	Voltage Gain $A_V = V_o/V_i$
	10			
	20			
	40			
	60			
	80			
	100			
	200			
	400			
	600			
	800			
	1000			
	2000			
	4000			
	6000			
	8000			
	10000			
	20000			
	40000			
	60000			
	80000			
	100000			

Calculation:- A graph is plotted a semi- log paper taking frequency on logarithimic scale [X axis] and output voltage on linear scale [Y axis]. The curve obtained is known as frequency response. Find 70.7% of the maximum value of V_o. Corresponding to 70.7%. Draw a horizontal line, which cuts the curve at two points on both sides of f_r, Note down lower cut at f_1 and upper cut at f_2. The difference $(f_1 - f_2)$ Hz gives the band width

$\Delta f = (f_1 - f_2) =$ __________Hz

$$Resonant\ frequency\ :- \qquad f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$Band\ width(B.W.):- \qquad \Delta f \ = f_2 - f_1 = \frac{f_r}{Q}$$

$$Quality\ factor\ \ Q = \frac{X_L}{R} = \frac{X_C}{R} = \frac{f_r}{B.W} = \frac{\omega_r L}{R} = \frac{1}{\omega_r CR}$$

Result:-

1. From the frequency response curve, it can be seen that for a particular value of frequency f_r the voltage V_c is maximum.
2. The band width changes for various values of R. It becomes more flat when the value of R is large/ small.
3. The quality factor also depends upon R.

Precaution:-

1. Input voltage applied to the circuit, should be kept constant, throughout the experiment and it should be checked for every frequency before recording other voltage.
2. For obtaining sharp resonance the ration L/C should be as high as possible.
3. The impedance of the voltage measuring meter should be very high.

Student Activity:-

Change the one by one value of resistor, Capacitor and Inductor and Note down the changes occurred in RESONACE FREQUENCY and Q. Discuss this results in group.

Experiment No:-13

Low pass & high pass filter:-

- The Low Pass Filter – the low pass filter only allows low frequency signals from 0Hz to its cut-off frequency, fc point to pass while blocking those any higher.
- The High Pass Filter – the high pass filter only allows high frequency signals from its cut-off frequency, fc point and higher to infinity to pass through while blocking those any lower.
- The Band Pass Filter – the band pass filter allows signals falling within a certain frequency band setup between two points to pass through while blocking both the lower and higher frequencies either side of this frequency band.

Depending on which way around we connect the resistor and the capacitor with regards to the output signal determines the type of filter construction resulting in either a **Low Pass Filter** or a **High Pass Filter**.

Aim:- To study frequency response of low pass & high pass filter.

Meaning:-

A low pass filter allows the voltage of low frequencies to pass through i.e. lower frequencies are filtered out and the voltage of high frequencies are not allowed to pass i.e. high frequencies are blocked.

A high pass filter allows the voltage of high frequencies while lower frequencies are blocked.

A band pass filter allows a band of frequencies ranging from f1 to f2. It blocks i.e. does not allow to pass frequency lower than f1 and higher than f2 and only a band between f1 and f2 allowed to pass through it.

These filter are constructed simply by using combinations of Resistor R and capacitor C.

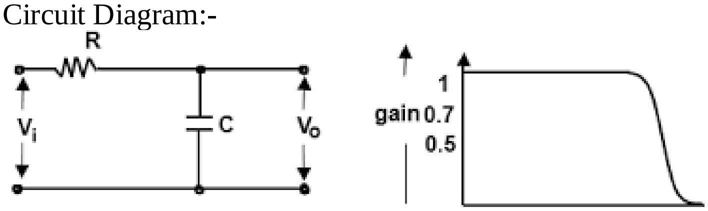
Apparatus:- Capacitance of known values, resistance box preferably a decade resistance box , an AF oscillator, a step down transformer, CRO etc.

Formula:-

$$Low\ pass\ filter:- \qquad V_o = \frac{1}{RC}\int V_i dt$$

$$High\ pass\ filter:- \qquad V_o = RC\frac{dV_i}{dt}$$

Circuit Diagram:-



(a)RC low Pass Filter Circuit

(b) Frequency ResponseCurve

Figure 1

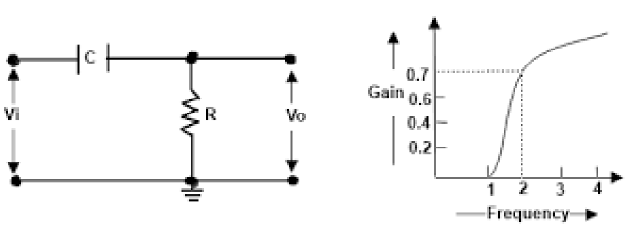


Figure 1 High--pass Circuit

Procedure:-

1. Connect the various components as shown in figure. Where R is the resistance box and C the capacitor.
2. Adjust the output of audio/ oscillator for an appropriate value and keep it constant throughout the experiment.
3. Change frequency of the audio oscillator from lower limit say 100 Hz to the highest frequency upto 1,00,000 Hz in suitable steps. For every frequency of the audio oscillator note the output voltage across the capacitance C.

4. You may repeat the experiment for different combination of L,C & R.

Observation:-

For, C=________________ microfarade and R= ______________ ohm

Observation Table:-

1] For low pass filter:-

For, C=________________ microfarade and R= ______________ ohm

S.N.	Frequency in Hz	Input Voltage V_i	Output voltage V_o	Voltage Gain $A_V = V_o/V_i$
	10			
	20			
	40			
	60			
	80			
	100			
	200			
	400			
	600			
	800			
	1000			
	2000			
	4000			
	6000			
	8000			
	10000			
	20000			
	40000			
	60000			
	80000			
	100000			

1] For High pass filter:-

For, C=________________ microfarade and R= ______________ ohm

S.N.	Frequency in Hz	Input Voltage V_i	Output voltage V_o	Voltage Gain $A_V = V_o/V_i$
	10			
	20			
	40			
	60			
	80			
	100			
	200			
	400			
	600			
	800			
	1000			

	2000			
	4000			
	6000			
	8000			
	10000			
	20000			
	40000			
	60000			
	80000			
	100000			

Calculation:- A graph is plotted a semi- log paper taking frequency on logarithimic scale [X axis] and output voltage on linear scale [Y axis]. The curve obtained is known as frequency response. Find 70.7% of the maximum value of V_o.

Result:-

1. Lower half power point frequency f_1=……….. Hz [Experimental] and ………………… [Theoretically].
2. Upper half power point frequency f_1=……….. Hz [Experimental] and ………………… [Theoretically].
3.

Precaution:-

1. Input voltage applied to the circuit, should be kept constant, throughout the experiment and it should be checked for every frequency before recording other voltage.
2. The electrolyte condenser should not be use.

3. The impedance of the voltage measuring meter should be very high.

Student Activity:- Find out the application of Low and high filter in electronic and discuss the application in group.

Semester -IV

Experiment No:-01

Newton's rings is a phenomenon in which an interference pattern is created by the reflection of light between two surfaces—a sphericalsurface and an adjacent touching flat surface. It is named for Isaac Newton, who first studied the effect in 1717. When viewed with monochromatic light, Newton's rings appear as a series of concentric, alternating bright and dark rings centered at the point of contact between the two surfaces. When viewed with white light, it forms a concentric ring pattern of rainbow colors, because the different wavelengths of light interfere at different thicknesses of the air layer between the surfaces.

Aim : To determine the wavelength of sodium light by Newton’s Rings arrangement.

Apparatus: A plano- convex lens of large radius of curvature, optical arrangement for Newton’s rings, plane glass plate, sodium lamp,spherometer and a travelling microscope.

Formula : The wavelength of light is given by the formula

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$$

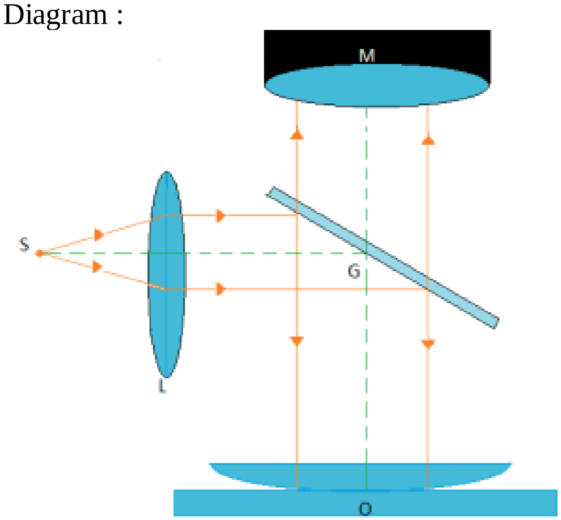
D_{n+p} → diameter of (n+p)th ring

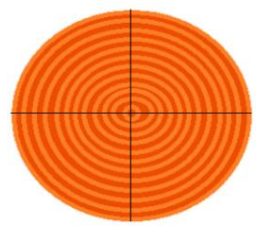
D_n → diameter of nth ring

P →an integer number of the rings

R→ radius of curvature of the curved face of the plano-Convex lens.

Diagram :





Procedure :

1. Place the long focus lens on the glass plate P .Set the plate G at 45^0 to the horizontal. Obtain a beam of parallel sodium light and rflect it vertically downwards on the lens. It will be reflected upwards into the microscope M which is focused on the point of contact O of the lens and plate P. A set of concentric rings, alternately dark and bright, their thickness decreasing with an increase in their radii, will be visible.
2. The first few rings are usually hazy and indistinct, hence,set the cross wire along the first clear dark ring. Take the reading on the vernier and bing the cross wire on the other side of the diameter of the same ring and again read he veriner. The difference gives the diameter of this nth ring.
3. Measure the diameters of some 20 consecutive rings and combine first with eleventh, second with twelfth and so on while calculating wavelength.The radius of curvature of the plano-convex lens is determined by Spherometer by the formula
$$R = \frac{l^2}{6h} + \frac{h}{2}$$
4. Draw a graph between D_n^2 and n. Detemine D_n^2 for n= 1 and n= 6, Calculate R, by taking wavelength 5893A^0.

Observation :

i. Value of one divison on the main scale = ___________cm
ii. No. of division on the varnier scale = __________.

iii. Least count of microscope = Value of M.S.D. /(Total no. of division on V.R) =

iv. Radius of Plano- convex lens

Table for determination $D_{n+p}^2 - D_n^2$

No. of ring	Reading		Mean diameter D_n	No. of ring	Reading		Mean diameter D_{n+10}	$D_{n+p}^2 - D_n^2$ P=10	Mean $D_{n+p}^2 - D_n^2$	Wavelength λ
	Left	Right			Left	Right				
n				n+10						
n+1				n+11						
n+2				n+12						
n+3				n+13						
n+4				n+14						
n+5				n+15						
n+6				n+16						
n+7				n+17						
n+8				n+18						
n+9				n+19						

Calculation :

Radius of Plano Convex lens by spheometer

$$R = \frac{l^2}{6h} + \frac{h}{2}$$

= 100cm

The wavelength of sodim light is given $\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$

The value of $D_{n+p}^2 - D_n^2$ can alos be obtained using a graph . The graph is plotted between the square of diameter of the ring along Y axis and corresponding number along X axis.

Result : Wavalength of sodium light = _________ A^0.

Standard mean value of wavelength = ________ $A^{0.}$

Percentage error = ___________

Source of error and precaution :

1. A lens L o long focus should be taken so that the thickness of th air film increases slowly and the formula 2t= nλ is applicable. It applies strictly to parallel sided film.
2. Light should be incident normally on the lens.
3. Microscope should be focused on the point of contact O.
4. The glass plate and the lens must be clear. It dirty, clean them with benzene.

Student Activity:-

Replace the sodium lamp with mercury light. What will be happening? Discuss your opinion in group.

Experiment No:-02

Resolving Power:-

The ability of an optical instrument or type of film to separate or distinguish small or closely adjacent images.

Aim : To determine the resolving power of telescope .

Apparatus : fine wire gauge, sodium lamp , telescope , a rectangular slit of adjustable width, and travelling microscope etc

Formula : Resolving power of a telescope

R.P. = $(a / 1.22\ \lambda)$ (theoretical)

R.p. = $(aD/a'd)$ (practical)

Where, d = actual separation between two vertical wires of a gauze,

a' width of aperture in front of the telescope required to resolve two wire.

a daimete of the objective of the telescope.

D distance between the wier gauze and the telescope objective.

λ - wavelength o light used.

Resolving power: - Resolving power is defined as the ability of a microscope or telescope to distinguish two close together images as being separate. An example of **resolving power** is how well a telescope can show two stars as being separate stars.

Diagram:

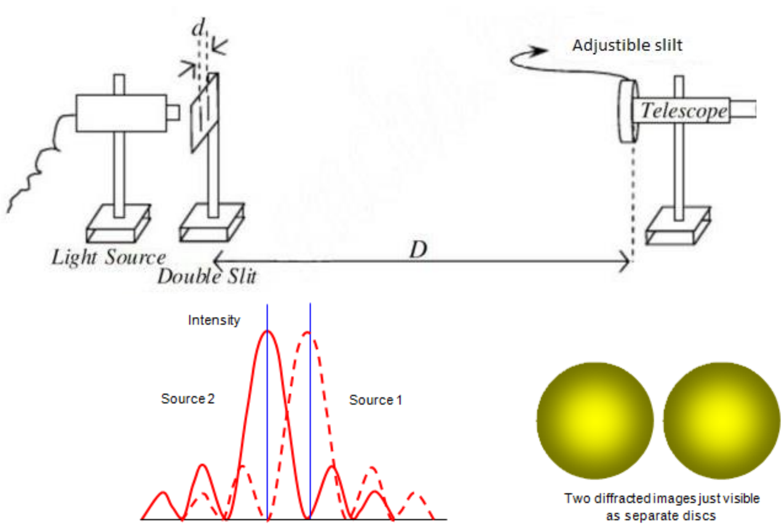


Figure 1

Procedure :

1. Set up the wire gauze with one set of wires vertical and illuminate itby placing the sodium lamp behind it.
2. Arrange a telescope some distance away on the side of the gauze away from the lamp and focus it on the gauze.
3. Place the slit of adjustable width just in front of the objective of the telescope and close to it , with its vertical edges parallel to the vertical wires of the gauze and make the slit wide open. The wires are clearly visible.
4. Narrow the slit gradually, the wires get less and less distinct till uniformly illumination results i.e. wires becomes just indistinguishable from each other. Measure the width of the slit a_1 by microscope.

5. Repeat the procedure starting from the closed slit slowly open the slit and find the width for which wires are just distinctily seen. Measure this width of the slit, say a_2 . The mean of a1 and a2 gives the required aperature ‘a’ for just resolution.
6. Measure the mean distance d between vertical wires of the gauze by measuring the distance, for say 20 consecutive wires. Measure the distance D, between the wire gauze and O the telescope objective.
7. Take a number of reading for different D.
8. Measure ‘a’ the aperture of the objective O of the telescope by means of verniers calipers.

Observation:

1. Least count of vernier calipers = _________cm
2. Aperture of the given telescope = _________
   i. ____cm
   ii. ___cm
   iii. _____cm
   iv. _____cm

   Mean aperture a= _______cm

S. R.	**D cm**	**d in cm**			**While closing the slit a1**			**While opening the slit a2**			**a’= (a1 +a2) / 2**	**R. P.**	**Mean R. P.**
		MSR	VSR	Total	MSR	VSR	Total	MSR	VSR	Total			
1													
2													
3													
4													
5													

Resolving Power

R.P. = $(a / 1.22\ \lambda)$ (theoretical)

R.p. = $(aD/a'd)$ (practical)

Here , λ = Average wavelength =

Result : Resolving power (R.P.) of given telescope in as found by

i. Theoretically =
ii. Experimentally=

Source of error and precaution:

1. The edge of the slit and the vertical wires of the gauze should be parallel.
2. Adjustable slit should be kept very close to the objective of the telescope.
3. Position of the telescope and the two sources should not be disturbed unless both the reading a1 and a2 are noted.
4. While using the travelling microscope, the screw should be rotated in one direction only to avoid the back lash error.

Student Activity:
Change the wavelength of light (by using different types of lamp/ Filter) and find the effect on resolving power of instrument.

Experiment No:-03

Plane diffracting grating:-

An arrangement consisting of a large number of equidistant parallel narrow slits of equal width separated by equal opaque portions is known as a diffraction grating.

The plane transmission grating is a plane sheet of transparent material on which opaque rulings are made with a fine diamond pointer. The modern commercial form of grating contains about 6000 lines per centimeter.

The rulings act as obstacles having a definite width 'b' and the transparent space between the rulings act as slit of width 'a'. The combined width of a ruling and a slit is called grating element (e). Points on successive slits separated by a distance equal to the grating element are called corresponding points.

Aim : To determine the wavelength of laser beam using a plane diffracting grating.

Apparatus : Optical bench, grating, source of laser beam, Screen, meter scale

Formula :

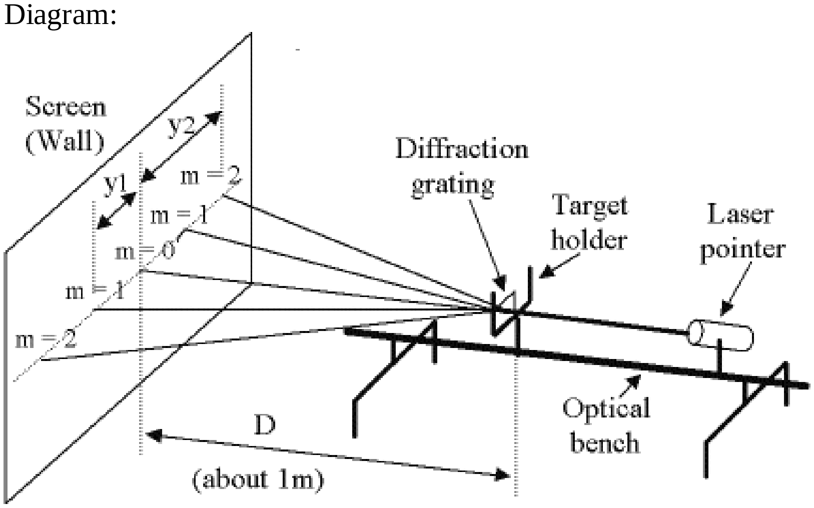
$$\lambda = \frac{(a+b)sin\theta_n}{n}$$

(a+b) = grating element,

θ_n angle of defraction for nth order.

n= order of spectrum.

Diagram:



Procedure :

1. Fix the grating and laser beam on the optical bench as shown in figure.
2. Passed the laser beam through grating and obtain diffracting pattern on the screen.

3. Note down the distance between screen and grating say D.
4. Note down the distance of first order and second order diffracting pattern from the centre or zero order spot on both side and calculate the mean say d.
5. Note down the grating element or numbers of line on the grating.
6. By using the formula calculate the wavelength of laser beam.
7. Read the number of lines per inch ruled on the grating .

Observation :

1. No. of lines ruled on the grating = 15000 per inch

=15000/ 2.54 per cm

Therefore grating element (a+b) = 2.54/ 15000 cm =

S.N.	Distance between screen to grating D	Order	Distance of spot from centre spot or zero order spot d			$\vartheta = \frac{d}{D}\frac{180^0}{\pi}$	sinθ	Wavelength	Mean Wavelength
			L.H.S	R.H.S	Mean				
1		First order							
		Second order							
2		First order							
		Second order							

Calculation :

For first order n= 1

$$\lambda = \frac{(a+\ b)sin\theta_1}{1}$$

=

=

=

For second order n= 2

$$\lambda = \frac{(a+\ b)sin\theta_2}{2}$$

=

=

=

Result : Wavelength of laser beam = __________ A^0.

Standard mean value of wavelength = _________ $A^{0.}$

Percentage error = ____________

Source of error and precaution :

1. Laser beam should not looked directly. It is hazardous to the eyes.
2. The laser is to be switched off after noting observations or when not required.

Student Activity:

Replace grating with simple glass plate and observed the result and discuss yours observation with group.

Experiment No:- 04

An arrangement consisting of a large number of equidistant parallel narrow slits of equal width separated by equal opaque portions is known as a diffraction grating.

The plane transmission grating is a plane sheet of transparent material on which opaque rulings are made with a fine diamond pointer. The modern commercial form of grating contains about 6000 lines per centimeter.

The rulings act as obstacles having a definite width 'b' and the transparent space between the rulings act as slit of width 'a'. The combined width of a ruling and a slit is called grating element (e). Points on successive slits separated by a distance equal to the grating element are called corresponding points.

Monochromatic:-
In physics, *monochromatic* describes light that has the same wavelength so it is one color. Broken into Greek roots, the word shows its meaning: *monos* means one, and *khroma* means color. Things that are truly monochromatic are rare

Aim : To determine the wavelength of Sodium light (Monochromatic light) using a plane transmission grating.

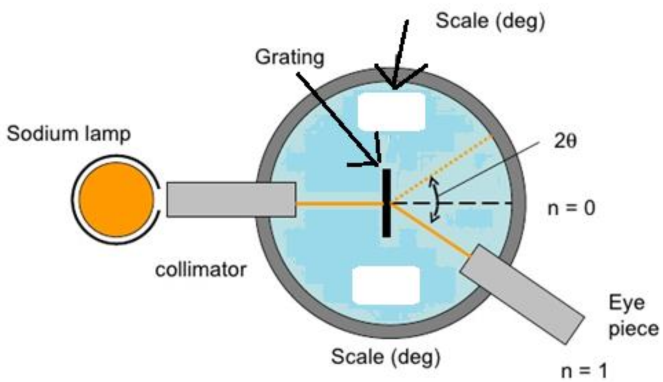
Apparatus : Grating, Spectrometer , Sodium lamp, spirit level

Formula :

$$\lambda = \frac{(a+ b)sin\theta_n}{n}$$

(a+b) = grating element, θ_n angle of defraction for nth order, n= order of spectrum.

Diagram:



Procedure :

1. Level the prism table with the help of spirt level .focus the eye piece on cross wires adjust the the telescope and collimator for parallel rays with the help of Schuster's method as explained.
2. Bring the telescope in line with collimator to have the sharp image of theslit coincident with the vertical cross wire as shown in fig without placing the grating on the prism table.
3. Adjust the reading of spectrometer windows w1 and W2 to be 0 or 360 degree by rotating the prsim table.
4. Fix the grating on prism table of spectrometer.
5. Note down the directed reading
6. Note down the reading for first and second order on both sides ie LHS and RHS side.
7. Determined the angle for first and second order diffracting .
8. Note down the grating lines on the grating.
9. Calculate the wavelength of sodium light

Observation :

1. No. of lines ruled on the grating = 15000 per inch

=15000/ 2.54 per cm

Therefore grating element (a+b) = 2.54/ 15000 cm =

S.N.	order	Windows	Position of telescope on LHS			Position of telescope on LHS			2ɵ	ɵ	Mean ɵ	Wavelength
			MSR	VSR	Total Reading	MSR	VSR	Total Reading				
1	First order	W1										
		W2										
2	Second order	W1										
		W2										

Calculation :

For first order n= 1

$$\lambda = \frac{(a+\ b)sin\theta_1}{1}$$

=

=

=

For second order n= 2

$$\lambda = \frac{(a+\ b)sin\theta_2}{2}$$

=

=

=

Result : Wavelength of Sodium light = __________ A^0.

Standard mean value of wavelength = _________ $A^{0.}$

Percentage error = ____________

Source of error and precaution:

1. All adjustments of the spectrometer must be correctly made.
2. The grating must be adjusted so that its plane is vertical and ruling on it must also be made vertical.
3. In measuring angles, the left side of the image must be made to coincide with the vertical cross wire for positions of telescope on either side of the central image.
4. The light must be incident on that side of the grating on which there are no ruling. This is done to secure that no refraction occurs after diffraction has taken place.

Student Activity:

Replace the monochromatic source of light with mercury light and observed the pattern discuss result with group member.

Experiment No:05

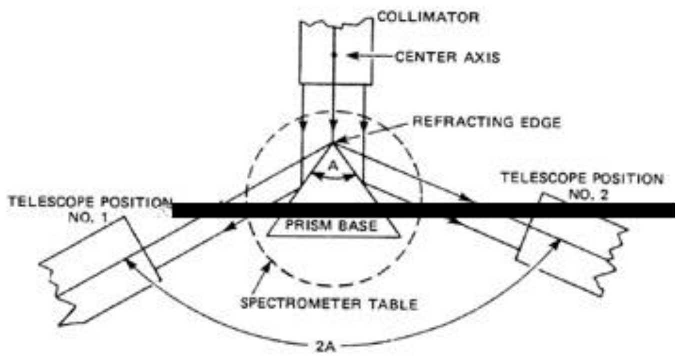
Refractive index:

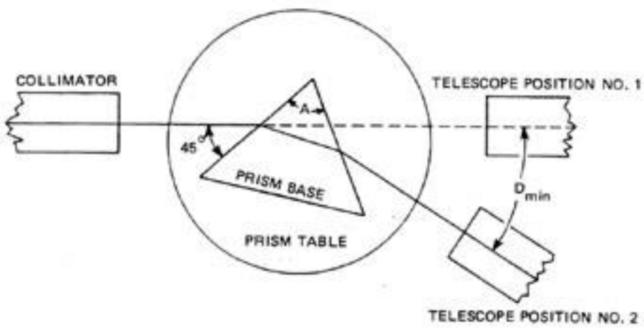
The **refractive index** or **index of refraction** of a material is a dimensionless number that describes how light propagates through that medium. It is defined as n=c/v where *c* is the speed of

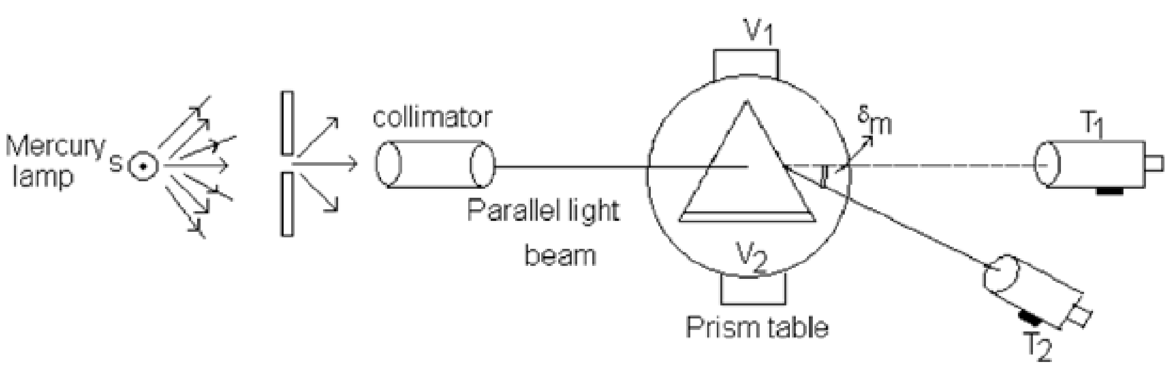
light in vacuum and v is the phase velocity of light in the medium. For example, the refractive index of water is 1.333, meaning that light travels 1.333 times slower in water than in the vacuum.

Aim	**:**	**To determine refractive index of a flint glass prism.**
Apparatus	:	Spectrometer , sodium lamp flint glass prism, reading lens, spirit level etc.
Formula	:	The refractive index of the material of the prism is given by the formula $\mu = \frac{sin\left(\frac{A\ +\delta m}{2}\right)}{sin\frac{A}{2}}$
		Where, A= angle ofprism.
		δ_m = angle of deviation.

Diagram:







Procedure :

Measurement of A:

1. Make all the adjustments of the spectrometer as explained.

2. Place the prism of on the prism table with its refracting edge pointing towards the collimator scuh that light from the slit falls on both faces of the prism. Rotate the telecscope in thedirection OP and then along OQ to see if the slit is visible from the both sides. If not ,rotate the prism till this is so. Now bring the telescope in the direction OP and make the left side of the slit coincide with its vertical cross wire and read both verniers. Next ,rotate the telescope in the direction OQ and again read both verniers. Half the angle POQ = A.

Measurement of δ_m:

1. Allow light from the collimator t o fall on one face AB of the prism . For this purpose the prism is put on the table with its refracting edge pointing to the right. Receive the emergent ray in the telescope and fix the telescope. Now rotate the prism in one direction only. The slit will appear to travel towards OP', stop and then reverse. If this is not so, shift the position of the telescope and try again. Now, so adjust the telescope that the slit reverses when its left side just touches the cross wire. Now, so adjust the telescope that the slit reverse when its left side just touches the corss wire. Fix the table in that position. Read the vernier.
2. Remove the prism and take the direct reading by bringing the telescope along OP'. Read the verniers. <angle P'OP" is the minimum deviation δ_m. Calculate μ.

Observation :

1. Vernier constant of the spectrometer= _________

For A

S.R.	Window	First position of telescope	2nd position of telescope	2A
	W1			
	W2			
	W1			
	W2			

For δ_m

S.R.	Window	Min deviation position	Direct ray	δ_m
	W1			
	W2			
	W1			
	W2			

Calculation :

$$\mu = \frac{sin\left(\frac{A + \delta m}{2}\right)}{sin\frac{A}{2}}$$

Result : Refractive index of prism found to be __________

Source of error and precaution :

1. A narrow slit must be used.
2. All adjustments must be made carefully.
3. For all readings make the left of the image of the slit coincide with the vertical cross wire of the telescope.

Student Activity:

Using different size/ length of prism repeat same experiment find out the refractive index. Discuss the result in group.

Experiment No:-06

CRO:- The cathode-ray oscilloscope (CRO) is a common laboratory instrument that provides accurate time and aplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability, and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode-ray tube.

Frequency Generator:- A **signal generator** is an electronic device that generates repeating or non-repeating electronic signals in either the analog or the digital domain. It is generally used in designing, testing, troubleshooting, and repairing electronic or electroacoustic devices. There are many different types of signal generators with different purposes and applications and at varying levels of expense. These types include **function generators**, **RF and microwave signal generators**, **pitch generators**, **arbitrary waveform generators**, **digital pattern generators** and **frequency generators**.

Aim : To determine frequency and phase of signal using CRO.

Objective : To determine unknown frequency using Time base CRO

To determine unknown Voltage using Time base CRO

To measure the phase difference between current and voltage in R-C circuits using CRO.

Apparatus : Time base CRO, signal source whose frequency is to be determined or AFO ,Step down transformer potentiometer, resistance box, capacitor of known capacitance and inductor of know n induction, two key.

Formula : for phase difference determination

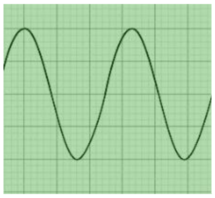
$sin\varphi = \frac{b}{a}$

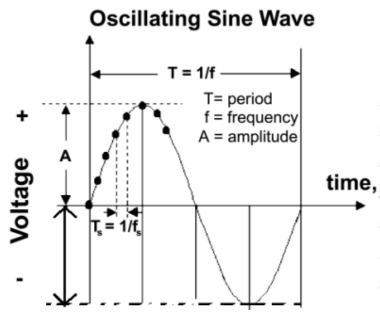
$$\varphi = sin^{-1}\left(\frac{b}{a}\right)$$

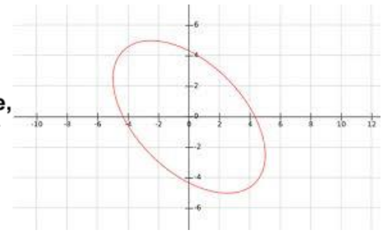
For frequency determination

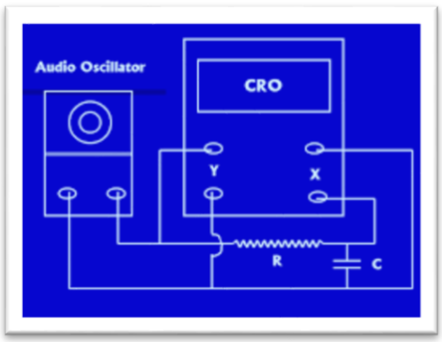
$$f = \frac{1}{T}$$

Diagram;-









Procedure : For phase difference :

1. Make the connection as shown in figure.
2. A potentiometer is connected across the secondary of step down transformer whose output V_0 is the ac input voltage to both the combinations L-R or C-R by putting keys K_1 and K2 "ON" respectively .
3. Here L and C are pure inductance and capacitance while R is variable resistance from resistance box.
4. Disconnect the sweep generator by setting the sweep control to EXT.INPUT position.
5. Switch ON the cro and focus the spot and set it at the centre of the screen . Consider first C-R combination close key K1.
6. To measure the phase difference two signals V_c and V_{cR} connect terminal B to X plate and terminal A to Y plate of CRO . Terminal G is connected to GND(ground).
7. Adjust the value of variable resistance R so that we get an incilinde ellipse on the screen of CRO. Sketch th lissajous pattern and measure the lengths 2a and 2b.
8. Take number of readings with different values of R.
9. To study the C-R combination, now close key K2 and K1 is open so that the inductor C in circuit with resistance R.
10. Repeat the experiment with different values of R and note down the values of 2a and 2b for each sketch of the inclined ellipse.

Determination of Frequency.

1. Switch ON the time /base CRO.
2. Connect the unknown AC source to Y input of the CRO.
3. By using foucus and INT knobs , obtain a sharp wavefrom on the screen. Now adjust time base selector switch to get distinct number of waves which will be countable on the screen.
4. The waveforms are connected by HOR-SHIFT and VER-SHIFT knob and of proper amplitude using VER-GAIN.

5. Bring the starting of a wave to the LHS of the scale count the maximum number of complete waves and the note down the distance occupying these waves. Note down the time base you have selected.
6. Change the time base and again repeat above procedure.

Observation :

For frequency determination:

S.R.	Applied Frequency	Time/ Div (a)	Number of division along X axis in one wave (b)	Time Period= a x b	Frequency $f = \frac{1}{T}$	
1						
2						
3						
4						
5						

For Voltage determination:

S.R.	Applied Voltage	Volt / Div (a)	Number of division along Y axis (b)	Voltage= a x b		
1						
2						
3						
4						
5						

For Phase Difference:

S.R.	Component in circuit	Resistance	Length		Length		Observed phase difference
		R ohms	2a	a	2b	B	$\varphi = sin^{-1}\left(\frac{b}{a}\right)$
1	Inductor L						
2							
3							
1	Capacitance C						
2							
3							

Calculation :

Observed value of φ _______ (C R circuit)

Theoretical value of

$$\varphi = tan^{-1}\left(\frac{1}{\omega CR}\right)$$

Observed mean value of Phase difference φ = ___________ "(for L-R circuit)

Theortical value of

$$\varphi = tan^{-1}\left(\frac{L\omega}{R}\right) = tan^{-1}\left(\frac{2\pi fL}{R}\right)$$

Result :

1. The phase difference for C-R and LR circuit is found to be ________ and _________ respectively which is nearly equal to its corresponding value calculated from theoretically.
2. The unknown frequency of the given A.C. source is found to be _____Hz.

Source of error and precaution :

3. The pattern must be steady. Hence locking must be done by Syno control.
4. The time base must be selected properly.

Student Activity:- discuss the block diagram of CRO.

Experiment No:-07

Self-inductance:- Self-inductance is defined as the induction of a voltage in a current-carrying wire when the current in the wire itself is changing. In the case of self-inductance, the magnetic field created by a changing current in the circuit itself induces a voltage in the same circuit.

Mutual inductance:- Mutual Inductance is the interaction of one coils magnetic field on another coil as it induces a voltage in the adjacent coil

bridge rectifier:- A **bridge rectifier** is an arrangement of four or more diodes in a **bridge** circuit configuration which provides the same output polarity for either input polarity. It is used for converting an alternating current (AC) input into a direct current (DC) output.

Aim : To determine self and mutual inductance of a pair of coils using a bridge rectifier method.

Apparatus : a bridge rectifier using four diodes (OA 79, BY 127), milliammeter, ac voltmeter , a pair of coils wound above the other (or transformer), a source of variable alternating emf

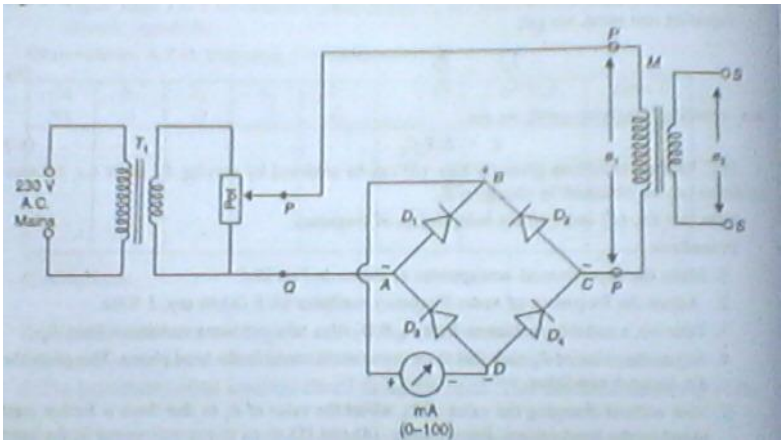
Formula : Self inductance of primary coil,

$$L_P = 2.8 \times \frac{ac\ votage\ reading\ across\ primary(V_{PP})}{mA\ Reading}$$

Mutual inductance:

$$L_M = 2.8 \times \frac{ac\ votage\ reading\ across\ secondary(V_{ss})}{mA\ Reading}$$

Diagram:



Procedure : A circuit diagram is shown in figure,. The transformer, the bridge rectifier circuit and the primary and secondary terminals can be fitted on a circuit board. A veriac can be used at P and Q if the primary voltage of th coil is too large or a step down transformer followed by a potential divider arrangement is used if the primary emf of the coil is to be small. The ac voltmeter used for measuring e1 and e2 id of the range o-250V if the virac is used. It can be of 0-10V range if a step dwon ttansformer is used . The milliammeter of the range of 0-100mA (D.C).

Measurement of self inductance of primary coil:

3. Connection are made as shown in figure.
4. An ac voltmeter of proper range is connected across the primary terminals (PP).sc
5. Gradually go on changing the primary emf in steps by rheostat or potentiometer the reading of ac voltmeter and the corresponding mA reading are noted .Take at least ten readings. Tabulate the readings as in table No.1

Measurement of self inductance of primary coil:

1. In order to measure mutual inductance, the ac voltmeter of desired rang is connected across the secondary terminals (SS).
2. Gradually go on changing the primary emf in steps by rheostat or potentiometer the reading of ac voltmeter at the secondary and the corresponding mA reading are noted carefully .Take at least ten readings. Tabulate the readings as in table No.1

Observation :

Table no 1 : for measurement of self inductance L_p

S. R.	Mill ammeter reading (m A)	AC voltmeter reading across primary V_{pp}	AC voltmeter reading across primary V_{ss}	Lp	L_M	Mean L_p in henry	Mean L_M in henry

Calculation :

$$L_P = 2.8 \times \frac{ac\ votage\ reading\ across\ primary(V_{PP})}{mA\ Reading}$$

Mutual inductance:

$$L_M = 2.8 \times \frac{ac\ votage\ reading\ across\ secondary(V_{ss})}{mA\ Reading}$$

Result :

1. The self- inductance of primary coil was found to be ______ henry.
2. The mutual inductance between the Primary and secondary coils is found to be _____________henry

Source of error and precaution :

1. Since the current in mA is dc hence check its polarity before switch on the circuit.
2. High range or low range ac voltmeter should be used depending on whether a step down transformer id used across the bridge circuit.
3. Don’t touch the naked wire, if you are using veriac.

Student Activity:- Replace the position of coil1 to coil2 and vice versa note down the reading and discuss the observation in group.

Experiment No:- 08

The **RC time constant**, also called tau, the time constant (in seconds) of an RC circuit, is equal to the product of the circuit resistance (in ohms) and the circuit capacitance (in farads), i.e. t= RC

It is the time required to charge the capacitor, through the resistor, from an initial charge voltage of zero to ≈63.2 percent of the value of an applied DC voltage, or to discharge the capacitor through the same resistor to ≈36.8 percent of its initial charge voltage.

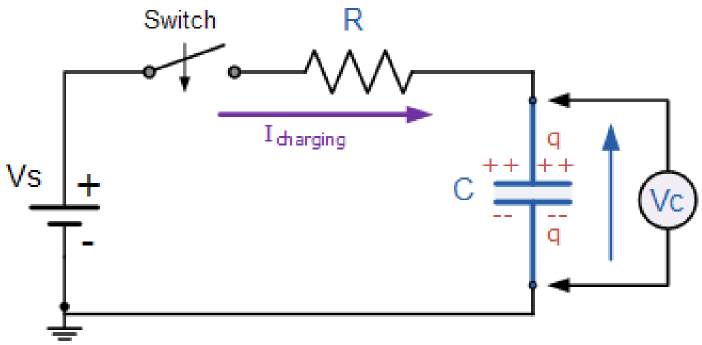
Aim:- To study decay of current in RC circuit- using Micro ammeter.

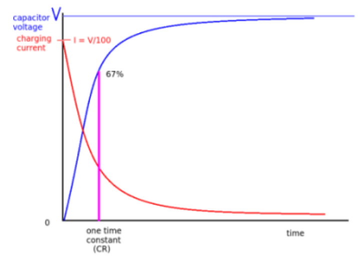
Apparatus:- High resistance, electrolyte condenser (1000 microfarad), micro-ammeter (0-100 ranges) battery, one way key ,Morse key ,stop watch, connecting wires etc.

Formula:

t= RC

Circuit:-





Procedure:

1. Make the connection as shown in circuit (25.9)
2. Morse key is connected such that condenser is always connected to C pint i.es. a common point. The negative terminal of battery is connected to make pinit b and microammeter is connected to point a the break pint.
3. Charge the condenser c by pressing Morse key K for about 20sec, and release it. The momet Morse key is released, point c comes in contact with point a . The condenser starts discharging through R . we observe large deflection in micro ammeter.
4. As the condenser starts discharging through R, the microammeter readings goes on decreasing . At some suitable position, say 90 μA pointer reading , start the stop watch Hence at t=0 ,current I0= 90μA.
5. Record the decrease (i.e. discharge) of current in micro ammeter at an interval of 5 sec initially and then of 10 sec interval till the current drops to zero value.
6. You may repeat above steps for another value of R.

Observation:- Capacity of condenser C = ________ micro Farad = _________ x 10^{-6} Farad.

Observation Table:-

S. N.	Time in Sec	Micro –ammeter reading I in μA
1	0	
2	5	
3	10	
4	15	
5	20	
6	25	
7	30	
8	35	
9	40	
10	45	
11	50	
12	55	
↓	↓	

Calculation:- Plot a graph taking time (t) along Xaxis and current (I) along Y axis.We get ans exponential curve (25.10) & find out a point on Y axis corresponding to 0.3679 I_0 . Draw a horizontal line from this point. It will cut the curve at some point. Find the corresponding time on X axis. This gives t t, the time constant of RC

Result :- The time constant of RC is found to be_____________ second.

Sources of errors and Precautions:-

1. If the P.D. of battery is too high, use a potential divider arrangement to avoid Ammeter.
2. Connections of Morse Key Should be done carefully.
3. Polarity of electrolyte capacitor should be taken care of i.e. +ve of C should always be connected to +ve of battery.
4. Large number of readings be taken to minimize the error.
5. Contacts must be tight, so as to minimize the contact resistance.

Student Activity:- Change the value of Capacitor and resistor find out effect on time constant of RC circuit. Discuss the result and application of its.

Experiment No:-09

Stefan-Boltzmann law, statement that the total radiant heat energy emitted from a surface is proportional to the fourth power of its absolute temperature. Formulated in 1879 by Austrian physicist Josef Stefan as a result of his experimental studies, the same law was derived in 1884 by Austrian physicist Ludwig Boltzmann from thermodynamic considerations: if *E* is the radiant heat energy emitted from a unit area in one second and *T* is the absolute temperature (in degrees Kelvin), then $E= \sigma T^4$, the Greek letter sigma (σ) representing the constant of proportionality, called the Stefan-Boltzmann constant. This constant has the value 5.670367 × 10^{-8} watt per $metre^2$ per K^4. The law applies only to blackbodies, theoretical surfaces that absorb all incident heat radiation.

Aim:- To verify the Stefan's law of radiation by using an incandescent lamp.

Apparatus:- IC regulated variable d.c. power supply (0 to 10 V D.C at 2A) , digital voltmeter, digital ammeter (0- 2 A D. C.), incandescent lamp, patch cords or wires etc.

Formula :- $T = T_R (R_T/ R_R)^{0.8333}$

Where T is the temperature of tungsten filament of incandescent lamp.

R_T is resistance of bulb filament at particular temperature (T)

R_R is resistnace of bulb filament at room temperature.

T_R is room temperature.

σ is Stefan's constant.

A is surface area of filament.

ε = emissivity (ε =1 for black body and ε< 1 for other bodies)

Experimental arrangement:

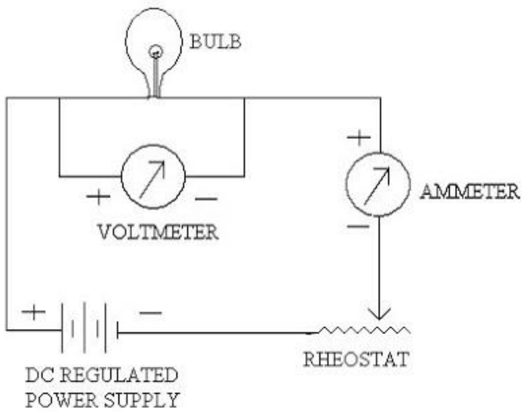


Figure 1

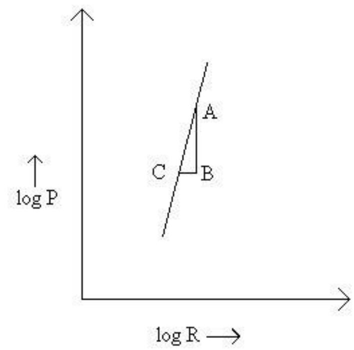


Figure 2

Procedure:-

1. Starting with low current, increase it gradually by potentiometer till the filament of the bulb just glows. This is called draper point. For better judgment of this draper, keep the bulb in a covered enclosed.
2. Note down V_D and I_D at this Draper point by digital panel meters and from this calculate R_D , the resistance of bulb filament at Draper point. $R_D= (V_D/ I_D)$
3. Note down the room temperature by a mercury thermometer, say T_R.
4. Substituting the values for R_D and T_R in equation $R_R = R_D\ (T_R/ 800)_{1.2}$
   We calculate R_R the resistance of bulb at room temperature.
5. Increase the voltage in steps and note down the voltage V_T and current I_T and calculate R_T at particular temperatures, using relation $R_T= V_T/ I_T$
6. We can calculate T by using the relation $T= T_R\ (R_T/ R_R)\ _{0.8333}$
7. Now at each setting of Voltage V_T and current I_T to lamp, calculate different temperature T of the bulb filament and power supplied $P= V_T \times I_T$.
8. Plot a graph by taking $\log_{10}$ T on X axis and $\log_{10}$ P on Y axis. We get a straight line.
9. Determine the slope of the line and note that it is nearly.
10. Also determine intercept on Y axis. This gives log σ. Taking antilog of this gives the value of σ the Stefan's constant in M. K. S. units.

Observation:-

1. Bulb 6V ,10 Watt
2. Room Temperature= _______ $_0$C , TR= 273 + ________= $_0$K
3. Bulb Resistance at Draper point $R_D = V_D/ I_D$== __________ ohm

Observation Tables:-

S.N.	V_T	I_T	$R_T=V_T/I_T$	$P=V_T.I_T$	Log_10 P	T = T_R (R_T/ R_R) 0.8333	$Log_{10}T$

Slope =

=

Intercept on Y axis = $\log^{10}\sigma$= OS

σ' = antilog OS =______________ Watt m^{-2} K^{-4}

Result:- the value of Stefan's constant is found to be _______________ Watt m^{-2} K^{-4}

Theoretical Value:- Theoretical value of Stefan's constant= 5.76x 10-8 Watt m^{-2} K^{-4}

Percentage of error:-

Error and Precautions:-

1. The value of obtained for Stefan's constant ====____________ Watt m^{-2} K^{-4}
2. is different than its theoretical value. The error is due to the surface area of the filament, emissivity and radiation losses. Try to minimize these losses.
3. During the measurement of R_D the voltage and current of D.C. power supply should be as minimum as possible.
4. Resistance at particular temperature R_T to be found by each setting of voltage and current of D.C. power supply but the value of R_R and T_R should be the same.

Student Activity:-

Replace the bulb with different volt/ watt and repeat the process and verify the Stefan's law and Discuss the result in group.

Experiment No:-10

Sonometer:- A sonometer is an apparatus used to study the transverse vibrations of stretched strings. It is in the form of a hollow wooden rectangular box. On the wooden rectangular box there are two bridges and a pulley at one end. A wire string is attached to one end of the wooden box, run over the bridges and pulley and carries a weight hanger at the free end.

Aim :- To determine frequency of A.C. mains with a sonometer using a magnetic wire.

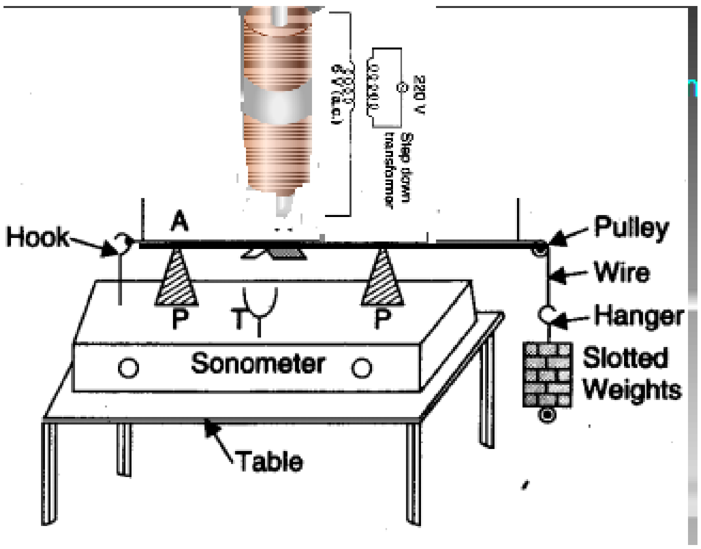
Apparatus:- Sonometer with steel wire, an electo-magnet, a step down transformer, balance, weight box, meter scale.

Formula:-

Frequency of vibrating string n and frequency of A.C. mains f.

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}, \qquad n = \frac{1}{2l}\sqrt{\frac{Mg}{m}}\ , \qquad f = \frac{n}{2} = \frac{1}{4l}\sqrt{\frac{Mg}{m}}$$

Experimental arrangement:-



Procedure:-

1. **Stretch a steel wire AB on a sonometer with a load of about 2 kg. connect an electromagnet to the secondary of a step down transformer.**
2. **Start the current through the electro- mangnet and bring one of its ends near the stretched steel wire. Adjust the position of the sliding wedges C and D so that when the electromagnet is put with its end near the middle of segment CD, the later is thrown into oscillations. The wire, however, should not vibrate so violently that it begins to slip on the knife edge.**
3. **Shift C and D so that the amplitude of the vibration is fairly large and is constant. Varying amplitude indicate that it is not a case of resonance, but of forced vibration. This can easily be seen by putting a piece of white paper under or behind the wire. It is better to start with D near the end B and move it gradually towards C till resonance occurs.**
4. **Measure the length CD and repeat the observation, the mean being the vibrating length l. The frequency, n of the vibrating wire is given by**

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}, \qquad n = \frac{1}{2l}\sqrt{\frac{Mg}{m}}\ , \qquad f = \frac{n}{2} = \frac{1}{4l}\sqrt{\frac{Mg}{m}}$$

Where Mg= tension in dynes and m= mass of 1cm of wire.

Now, the wire is pulled by the electro- magnet twice in each cycle- once when its end nearest the wire is a north –pole and again when it is south pole. Hence the frequency of the A. C. supply is n/2 cycles per second

5. **Repeat the experiment with tension = 2.5,3.0,3.5 kg**

Observation:-

Mass of 1cm of wire, m=______g

S. N.	**M kg**	**(l) in cm**	**Mean l**	$n = \frac{1}{2l}\sqrt{\frac{Mg}{m}}$

Frequency of vibrating string n= _____ Hz
Frequency of A. C. Supply f =n/2=_______ Hz
Calculation:- Frequency of A.C. main

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}, \qquad n = \frac{1}{2l}\sqrt{\frac{Mg}{m}}, \qquad f = \frac{n}{2} = \frac{1}{4l}\sqrt{\frac{Mg}{m}}$$

Result:- The frequency of the A. C. Supply= ____________ Hz

Sources of error and precautions:-

1. Sufficient load should be put on the wire to make it tight.
2. The end of the electro- magnet should be held close and opposite the middle of the vibrating segment.
3. For each load, the length should be taken at least twice.
4. It is helpful to hold a white paper behind or under the wire to judge its position of resonace or of maximum vibration.

Student Activity:

Search different method to find out the frequency of AC main and discuss in group its advantage and disadvantages.

Experiment No:-01

Crystral:- A **crystal** or crystalline solid is a solid material whose constituents (such as atoms, molecules, or ions) are arranged in a highly ordered microscopic structure, forming a **crystal** lattice that extends in all directions.

Unit cell: The smallest group of particles in the material that constitutes the repeating pattern is the **unit cell** of the structure. The unit cell completely defines the symmetry and structure of the entire crystal lattice, which is built up by repetitive translation of the unit cell along its principal axes.

Aim:- To study crystal models and identification of crystal planes

Appratus:- Crystal Modeles, Meter scale, Scale, D for angle measurement, Campas etc.

Fromula:

To determine the miller indices

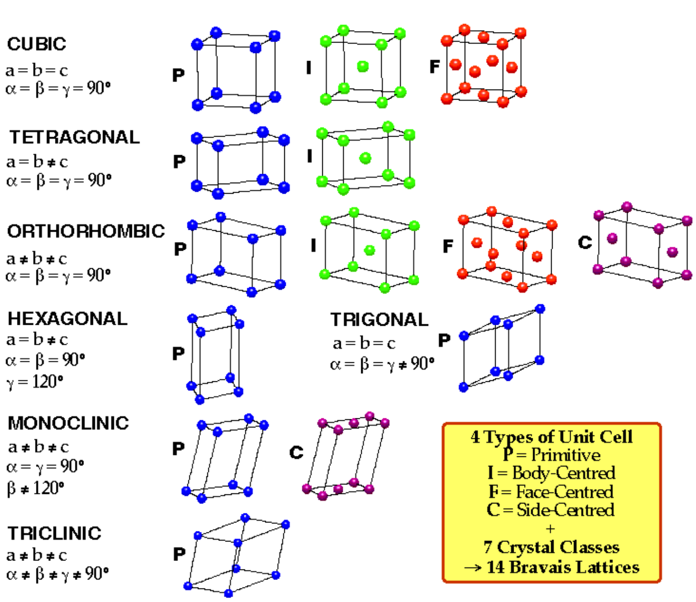
Intercept : Divide by unit intercept : 2a/a 3b/b 2c/c = 2 3 2

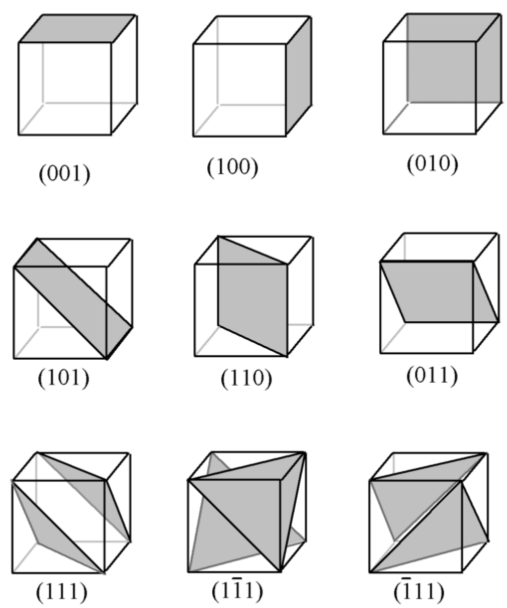
Reciprocal of intercept :

Multiply by LCM & convert into whole number

The result is Miller indices (h, k,l)

Diagram:-





Observation :

Determination of Crystal Model

S.N.	a	b	c	α	B	γ	Relation between a, b, c	Relation between α, β, γ	Identification of crystal Model

Model -1									
Model-2									
Model-3									
Model-4									
Model-5									

Determination of crystal Simple, F.C.C, B.C.C

S.N.	Number of atom				Primitive / Non primitive	Identification of crystal Model From observation Table I & II
	Corner	Centre of body	Face	Base		
Model -1						
Model-2						
Model-3						
Model-4						
Model-5						

Determination of Miller indices of crystal Plane

S.N.	Plane	Intercept			Divide by unit Intercept			Reciprocal of Intercept			Multiple by LCM put in parenthesis =Miller Indices= (h,k,l)
		X	Y	Z	a	B	c	1/a	1/b	1/c	
Model -1	Yellow										
	White										
Model-2	Yellow										
	White										
Model-3	Yellow										
	White										
Model-4	Yellow										
	White										
Model-5	Yellow										
	White										

Result:-

1. Model – 1 is ______________________and Miller Indices of crystal plane are ________________.
2. Model – 2 is ______________________and Miller Indices of crystal plane are ________________. Model – 3 is ______________________and Miller Indices of crystal plane are ________________. Model – 4 is ______________________and Miller Indices of crystal plane are ________________. Model – 5 is ______________________and Miller Indices of crystal plane are ________________.

Student Activity:- Search the method to growth of crystal structure try to grow the crystal.

Experiment No:-02

Thermister:- Thermistor is a type of resistor whose resistance changes rapidly with the small change in temperature. In other words, it is a type of resistor in which the flow of electric current changes rapidly with small change in temperature. The word thermistor is derived from the combination of words "thermal" and "resistor".

A resistor is a type of passive component that restricts the flow of electric current to certain level. Resistors are mainly classified into two types: fixed resistors and variable resistors.

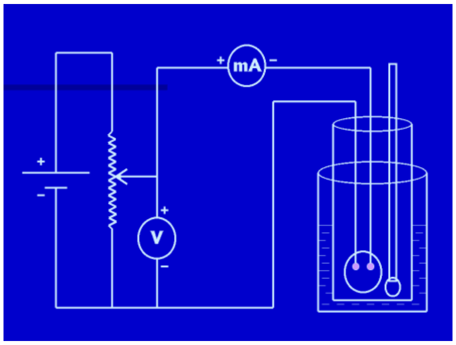
Aim:-To determine activation energy of Thermister.

APPARATUS: Thermistor, Thermometer (0 to 100 degree C.),Heating arrangement to heat the thermistor, Voltmeter, Milli-Ammeter, constant current source.

FORMULA:

Activation energy Eg = 0.396 x m eV, where m is the slope of the straight line plot obtained for log10 R and 1/T.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make the connections as shown in the circuit diagram. Heat the water in the beaker, so that the thermometer in the beaker should show the temperature of 75 degees C. Then the heating of water is stopped. After some time the thermometer shows the steady temperature.The applied voltage is suitably selected by sliding the slider on rheostat. Note down the voltage and current. Now the voltage across the thermistor should be kept constant throughout the experiment.
2. Make the connections as shown in the circuit diagram.
3. The thermistor along with the thermometer is placed inside the electric oven such that thermistor and thermometer bulb are side by side. To arrest the air circulation, the test oven is filled with cotton.

4. Adjust the pot-meter of constant current source to set the suitable current (2mA).
5. Switch on the oven power supply and keep it on until the thermometer show the temperature of 75 degees C.
6. Now switch off the oven power supply and allow it to cool up to room temperature.
7. As the thermistor cools down, voltage readings at different temperatures at intervals of 5degrss C are noted down and entered in observation table.

OBSERVATIONS:
Current =....... mA= .... A

Sr. No.	Temperature (Degrees C.)	Voltage (Volts)	Resistance (ohms)	Temperature (Degrees K)	10^3 / T	Log_{10} R
1	80					
2	75					
3	70					
4	65					
.....	...					
	20					

GRAPH:
Plot a graph of $\log_{10}$ R against 1/T. Slope of the curve is determined.
CALCULATIONS: Eg = slope x 0.396 eV.
RESULT:
The activation energy of given thermistor is found to be______________ eV.
PRECAUTIONS:
1. The temperature of the thermistor should not go beyond 80 degrees C.
2. The thermistor should be very close to mercury bulb of thermometer

Student Activity: Replace thermistor with simple resistor and repeat the experiment. Discuss yours observation and result in group.

Experiment No:03
Energy gap of semiconductor: In **semiconductors** and insulators, electrons are confined to a number of bands of **energy**, and forbidden from other regions. The term "**band gap**" refers to the **energy** difference between the top of the valence **band** and the bottom of the conduction **band**.

<u>Aim:- To determine energy gap of semiconductor using reverse bias method</u>
1. To make proper reverse bias connections for a given diode.
2. To observe the change in reverse saturation current with change in temperature of diode.
APPARATUS:
Thermometer, micro ammeter, battery, semiconductor diode, oven etc.
CIRCUIT DIAGRAM :

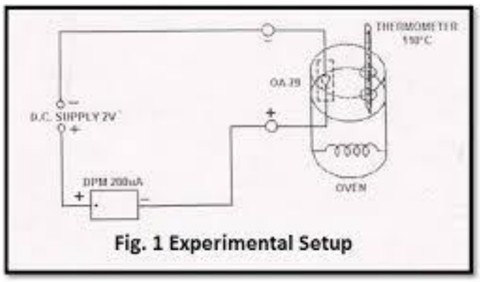
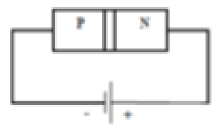


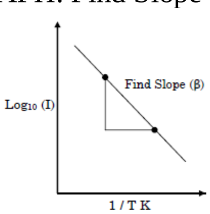
Fig. 1 Experimental Setup



PROCEDURE :
1) Make the connections as shown in figure.
2) Insert the thermometer in the hole provided with oven.
3) Now put the power supply ON/OFF switch to 'ON' position and see that the jewel light is glowing.
4) Put the 'OVEN' switch to "ON' position and allow the oven
temperature to increase up to 70 0C.
5) As soon as the temperature reaches 70 0C switch off the oven.
6) Take the readings during the fall of temperature from70 0C in step of 5 0C up to room temperature.
7) Tabulate your readings in the form as shown in the observation table.
8) Plot the graph between log I vs 1 / T K, the nature of graph is straight line.
9) Find the slop and calculate band gap Eg = 2kβ.
OBSERVATION TABLE :

Sr. No	Temp T 0C	Temp T K	1/T K	Current I (μA)	Log10 (I)
01	70				
02	65				
03	60				
04	55				
05	50				
06	45				
07	40				
08	35				
09	30				

GRAPH: Find Slope



SAMPLE CALCULATIONS :-
Band gap of a given semiconductor
Eg = 2kβ

where β = m = Slope of graph
and k = Boltzmann constant = 8.63 x 10 – 5 eV/K
Eg = ---------------------- eV
Result :-
Forbidden energy gap for germanium diode = ------------eV.

Student Activity:- Search different method to find out energy gap of semiconductor discuss its advantages and disadvantage in group.

Experiment No:-04
Thermocouple: A **thermocouple** is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor.
Thermo emf:- The **e.m.f.** set up in a thermocouple , when its two juncions are kept at different temperatures is called **thermo e.m.f.** A thermocouple is comprised of at least two metals joined together to form two junctions.

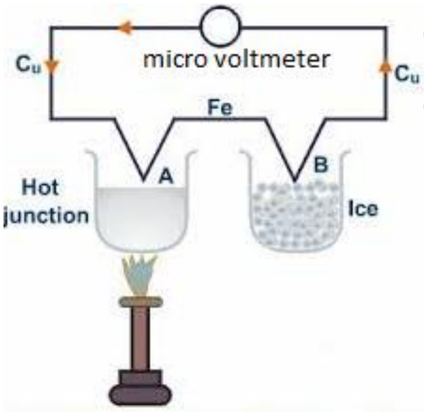
Aim :-To study thermo emf using thermocouple
Objective: To study variation of thermo-emf with temperature and to determine thermoelectric power for given thermocouple.
APPARATUS:
Thermocouple, DC micro-voltmeter, thermometer, electric oven, connecting wires, etc
THERMOCOUPLE

- The closed circuit formed by the connecting the ends of two wires of different metals is called thermocouple.
- The current flowing through this closed circuit, when twojunctions are maintaining at different temperature, is called as thermo-electric current.
- The corresponding e.m.f. which causes the current to flowis called the thermo-e.m.f.
- The production of the e.m.f. in a closed circuit made of two different metals, due to the temperature difference between the two junctions, is called “Seebeck effect” or “thermo -electric effect”.

THERMOELECTRIC SERIES
For given temperatures of hot and cold junctions, the direction of the current in thermocouple depends on the metals chosen. The metals are chosen in particular sequence which may be used to predict the direction of the current in the temperature range 00C to 1000C. This sequence is known as the thermoelectric series.
Antimony, Nichrome, Iron, Zinc, Copper, Gold, Silver, Lead, Aluminum, Mercury,
Platinum-rhodium, Platinum, Nickel, Constantan, Bismuth.
FORMULA:

$$\text{The thermoelectric power} = \frac{dE_{AB}}{d\theta}$$

DIAGRAM:



PROCEDURE:
1. Connect the thermocouple to digital microvoltmeter.
2. Insert hot junction into electric oven along with the thermometerand cold junction into beaker containing water.
3. Connect the oven power supply and start heating.
4. Measure the thermo emf EAB, for various temperatures at intervals of 50C.

OBSERVATIONS:

Sr. No.	Temperature (Degrees C.)	Thermo emf EAB (mV)
1	90	
2	85	
: : :	: : :	
	300C	

.
GRAPH:
Plot a graph taking temperature in along X-axis andcorrespondingthermoemfalong Y axis. Determine the slope of the curve $\frac{dE_{AB}}{d\theta}$.
.
RESULT:

The thermoelectric power $\frac{dE_{AB}}{d\theta}$. =
PRECAUTIONS:
1. The hot junction of thermocouple should be very close to mercury bulb of thermometer inside.
2. Select the suitable range on the microvoltmeter.
3. Note the thermo-emf and temperature accurately.
Student Activity:- Use single material wire and put one end in hot junction and other in cold note down the observation and discuss in group.

Experiment No:-05

X ray diffraction pattern:- X-Ray Diffraction (XRD) is a laboratory-based technique commonly used for identification of crystalline materials and analysis of unit cell dimensions. One of two primary types of XRD analysis (X-ray powder diffraction and single-crystal XRD) is commonly applied to samples to obtain specific information about the crystalline material under investigation. X-ray powder diffraction is widely used in geology, environmental science, material science, and engineering to rapidly identify unknown crystalline substances (typically in less than 20 minutes). A pure, finely ground, and homogenized sample is required for determination of the bulk composition. Additional uses include detailed characterization of crystalline samples, determination of unit cell dimensions, and quantitative determination of modal amounts of minerals in a sample. X-ray powder diffraction can also be applied to the identification of fine-grained minerals.

Lattice parameter:- There are many shapes and patterns of unit cells. To describe these shapes we use **lattice parameters**, or variables that describe the orientation of the unit cell. The typical lattice parameters that are used are the length of each side, which are typically labelled a, b, and c, and the angles between these sides, which are typically labelled α, β, and γ.

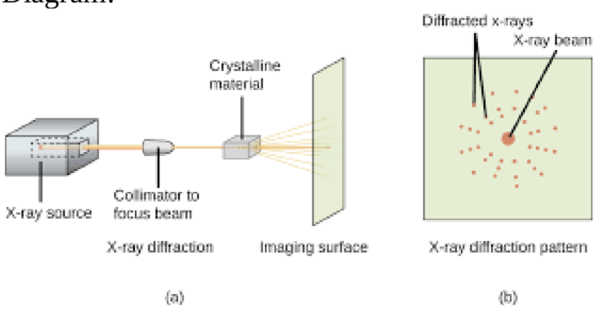
<u>Aim:-To determine lattice parameter using X-ray diffraction pattern.</u>

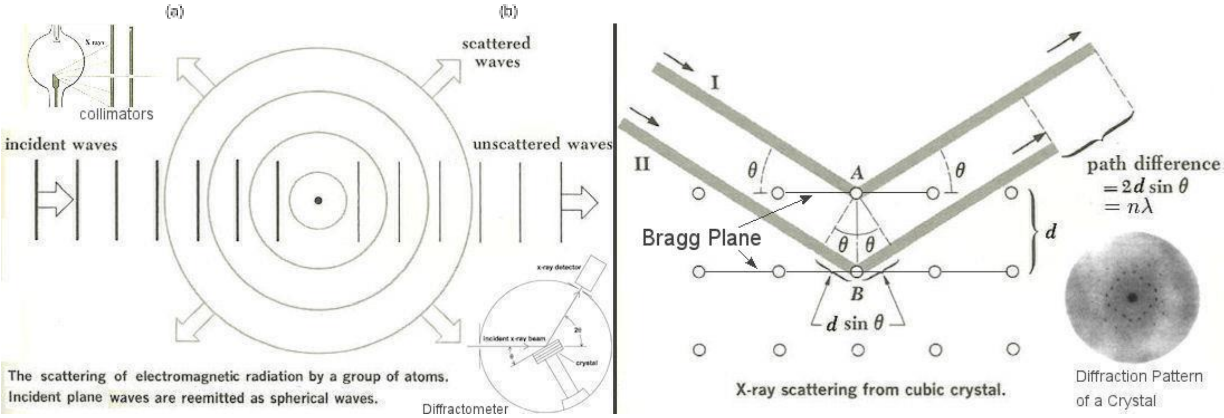
Apparatus: - Negative or positive film of the X ray powder photograph of cubic substance, travelling microscope or comparator.

Formulae:- $\theta = S/4$

$\sin^2\theta = \lambda^2/4a^2\,(h^2+k^2+l^2)$

Diagram:





Procedure:-

1. The given X-ray powder photograph film is mounted between two clean transparent glass plates and held them fimly together.
2. The film mounting so obtained is placed on the platform of a travelling microscope. The travelling microscope is focused on the lines of the film mounted.

3. Start from extreme left end say 8^{th} line in figure and focus the travelling microscope such that the horizontal cross wire just touches the 8^{th} line. Note down the readings of main scale and vernier scale.
4. Move gently the microscope towards right and focus it on next lower number of line i.e. 4^{th} line. Record the reading..
5. Repeat step 4 till we reach to the last line on right hand side, and every time note down the M.S.R and V.S.R. readings.

Note:- Usually all the readings should be noted only in one direction movement of the all travelling microscope to avoid the backlash error. However it is not possible to cover all lines at one strike.

6. Knowing the value of S, S/4 is calculated. This givens $\sin^2\theta$. Thus $\sin^2\theta_1$, $\sin^2\theta_2$, …….. etc are evaluated. The maximum common factor (x) of all $\sin^2\theta$ is calculated. Knowing x and λ and a can be determined.

Observations:-

1. Wavelength of X ray used, $\lambda = 1.53868$ A^0

Table for $\sin^2\theta$

S. N.	Powder lines	Travelling microscope readings						Distance between two lines S in cm	S in mm	Bragg angle θ= S/4	$\sin\theta$	$\sin^2\theta$
		L. H.S.			R. H.S.							
		M.S.R.	V.S.R.	T.R.	M.S.R.	V.S.R.	T.R.					

Calculations:-

Result:- The following conclusions can be drawn from the study of given X-ray diffraction photograph. These are:-

1.The lattice parameter of the unit cell of the crystalline substance is found to be ………. A^0.

2. The substance used in powdered form belongs to simple / f.c.c./ b.c.c cubic system.

3.The diffracting planes are found to be …….., ……., ………, etc. the Miller indices of the planes giving rise to experimental X-ray pattern.

4. The planes which were absent or weak are ….., ……, ….. etc.

Sources of error and precautions:-

1. Care should be taken to avoid backlash error, using the comparator or travelling microscope. Hence take reading only in one direction and taking leading in one direction and again coming back.
2. Care must be taken and it should be insured that the film holding glass plate one fimly fixed on the platform of the travelling microscope is not disturbe throughout the experiment.
3. The values of S must be substituted in mm only in the formula used for the calculation of $\sin^2\theta$.

Student Activity:-

Search about the different types method for finding lattice parameter. Discuss its advantage and disadvantage in group.

Experiment No:-06

Zener regulated power supply:-

The voltage from a half-wave/ full wave power supply is applied to a resistor R and a Zener diode connected in series. In normal operation, the Zener diode operates in the "reverse- breakdown" mode, in which the reverse voltage is equal to the nominal Zener voltage and is independent of the current (as long as the current in non-zero). The resistor R helps regulate the current through the Zener diode. As the load current is increased, some of the current that was flowing through the Zener diode is bypassed into the load device, reducing the Zener current, but the voltage remains constant.

Aim:-To study Zener regulated power supply

Appratus:- A variable D.C. supply, Zener diode, D.C. Voltmeter and ammeter with ranges accoriding to Zener diode supplied, two resistance boxes Rs and R_l connecting wires etc.

Formula:-

Satibility factor= $\frac{\Delta V_0}{\Delta V_i}$

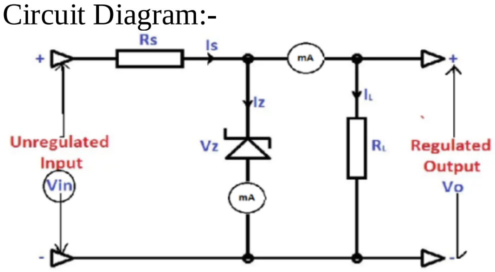
Where, ΔV_0 change in output voltage

ΔV_i change in input voltage

% Voltage regulation =

$$\frac{\text{D.C. output voltage with no load } V_{NL} - \text{D.C. output voltage with Full load } V_L}{\text{D. C. output voltage with Full Load } V_L} \times 100$$

Circuit Diagram:-



Procedure:-

1. Connect the Zener diode and other component as shown in figure.
2. The Zener diode is connected parallel to with the load resistane R_L across which the output voltage is desired R_s is a series i.e. line resistance. The zener is connected in reverse bias mode.
3. Introduce a fixed resistance R_s (100 to 500 ohm)in series with Zener diode. Keep R_s one taken as constant throughout the experiment. Introduce a load resistance R_L = 1000 ohm.
4. Stating from very low values of input voltage, increase in small steps well above the Zener breakdown voltage. For each observation note the input voltage and corresponding output voltage.

5. Plot a graph between input voltage taken along Xaxis and the output voltage taken along Y axis.

Voltage Regulation with load:-

6. For this , keep the input voltage at a value much more than the zener breakdown voltage. Starting from a low value of R_L say 10 ohm increase it in steps of 50 ohm upto full load. Note the resistance R_L and the corresponding output voltage V_0.
7. Plot a graph taking R_L along X axis and V_0 along Y axis.

Observations:-

For Input –output Characteristic

Line resistance $R_{s=}$ _________ ohm

Load Resistance R_L= ____________ohm

S.N.	Input voltage V_i	Output Voltage V_o	Output Current I in mA

2. For Voltage regulation with load

Line resistance R_s= __________ohm

Fixed input Voltage V_i= ___________ volts.

S.N.	Load Resistance R_L	Output voltage	Load current I_L in mA

Calculation:

Satibility factor= $\frac{\Delta V_0}{\Delta V_i}$

Where, ΔV_0 change in output voltage

ΔV_i change in input voltage

% Voltage regulation =

$$\frac{\text{D.C. output voltage with no load } V_{NL} - \text{D.C. output voltage with Full load } V_L}{\text{D. C. output voltage with Full Load } V_L} \times 100$$

Result:-

1. Stability factor is found to be______________.
2. Percentage voltage regulation of the given Zener diode =_____________ %

Precaution:-

1. Zener diode must be connected in reverse bias.
2. A resistance must be connected in series with the diode to limit the current at breakdown and should be kept constant.
3. To study the voltage regulation with load, the fixed input voltage to be kept must be much higher than zener breakdown voltage

Student Activity:- compare the working and application of zener and simple diode and discuss it in group.

Experiment No:-

Photocell:- a device in which the photoelectric or photovoltaic effect or photoconductivity is used to produce a current or voltage when exposed to light or other electromagnetic radiation. They are used in exposure meters, burglar alarms, etc

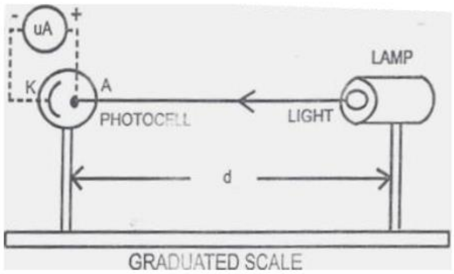
Aim :-To study Characteristics of Photocell

Objective: To verify inverse square law of radiations using a Photo-electric cell.

APPARATUS: Photo cell (Selenium) mounted in the metal box with connections brought out at terminals, Lamp holder with 60W bulb, Two moving coil analog meters (1000µA & 500mV) mounted on the front panel and connections brought out at terminals, Two single point and two multi points patch cords.

Formula:-

EXPERIMENTAL CIRCUIT:



PROCEDURE:

1. The experiment can be performed in the laboratory but it is always good to perform it in a dark room where stray light falling on the photocell can be avoided. In the dark room mount the various parts of the apparatus on the wooden plank provided with a ½ meter scale. Make the other connections as shown in the Fig. 4.
2. Switch on the lamp and adjust it at a suitable distance from the photocell so that the micro ammeter and mill-voltmeter indicate a reasonable deflection.
3. Change the distance of lamp from the voltaic cell and take a series of observations for the corresponding values of distance (d) and deflection (θ).

OBSERVATIONS:

Sr.No.	Distance from Photo Cell (d) to the lamp	Current	$E=I/d^2$

Result:- From graph and observation inverse square law of radiations using a Photo-electric cell is been verified.

PRECAUTIONS:

1. Stray light should be avoided
2. The effect of the reflected light from the bench surface should be minimized.
3. Very sensitive micro ammeter should be used.

Student Activity:- Use different types of bulbs and same watts and repeat this experiment and compare the photocurrent and discuss it in group.

Demonstrations- Any demonstrations **Mini project experiment** **Computer aided demonstrations**	**Visit to NPTL courses and virtual Lab**